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Developments in the field of informatics
in selected developing countries*

Prepared by
Carlos M. Correa
UNIDO consultant

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Introduction

The present report analyses the status and development strategies followed in specific segments of the electronics industry in a group of Latin American and Asian countries¹. It is based on previous UNIDO studies and on other documents and reports available on those countries².

The study concentrates on the informatics industry and on components (particularly, semiconductors) manufacture. Although these branches are rather incipient in the countries considered, they are among the most dynamic segments of the "electronics complex" and seem to offer significant opportunities for latecomer countries. Microcomputers production, for instance, increased in the Republic of Korea at a 90% annual growth rate from 1983 to 1987, and at a 70% annual rate in Mexico between 1985 and 1987. The Republic of Korea recently entered world competition in the field of semiconductors, and captured around 9% of the world market for certain memory chips (256K DRAMs), in 1987.

Interesting developments can also be identified in the six other countries selected for the study. Since the last decade, India is making important efforts in the electronics field, including in the area of minicomputers and semiconductors. Computer sales grew at an average of 70% over 1984-1986. Currently, it is undertaking an endogenous development in the field of supercomputers. Singapore has become one of the most successful international suppliers of computer peripherals and parts, in particular to the United States. Malaysia is one of the largest world producers and exporters of semiconductors³. In the case of Latin American countries, Brazil's informatics market is the largest in the Third World; national firms established in the framework of the national informatics policy account for more than 50% of that market. Argentina recently put into execution a policy aimed at fostering local informatics production. Venezuela has been one of the main importers of informatics equipment in Latin America, and reached the highest number of per capita computer installations in the region.

The countries selected for this review, as indicated by the precedent paragraphs, have not been based on any specific criterion. This report highlights the basic strategies followed in those countries and their results. It tries to identify common features and to explain the main differences. Certainly, the diversity in the overall paths and in the context in which the electronics industry has been established, makes it extremely difficult to comparatively assess the successes and

1 Argentina, Brazil, Mexico, India, the Republic of Korea, Malaysia and Singapore.

2 See, in particular, UNIDO, State-of-the art series on microelectronics No. 1, Venezuela, No. 2 India and No. 3 the Republic of South Korea, IS 498/492 and 490, 1984; UNIDO, Overview of the microelectronics industry in selected developing countries, IS. 500, 1984; UNIDO, The electronics industry in the Asean countries, Summary and principal conclusions, ID/WG/478/3 (SPEC), 1988.

3 In 1983 United States imported, under tariff regulations 806.3 and 807, semiconductors from Malaysia for US\$ 1.049, 74, almost half of all semiconductors imports from ASEAN countries.

failures of different countries. In most cases, there are no in-depth country studies, though the interest created by recent developments is beginning to stimulate new and valuable research⁴.

A point of interest is the extent to which the impressive results obtained by some countries in the informatics and semiconductor fields can be interpreted as evidence of "technological leap-frogging", as suggested by some theories on the emergence of a new "techno-economic paradigm" based on microelectronics technology⁵.

Section 1 of the report contains information on the size and relative importance of informatics goods and components in the selected countries, both in terms of local as well as international electronics production. Section 2 briefly describes the productive patterns prevailing in those fields, particularly on the levels of integration of local parts and components supplies. Section 3 compares the existing industrial structures, and the role of small, medium and large enterprises therein. Section 4 discusses the market-approaches of different countries, and particularly the export-oriented strategies of some Asian countries. Section 5 refers to the State's role in the development of the industrial areas considered in the report, and Section 6 to the forms of participation of direct foreign investment in that process. Section 7 analyses the mechanisms employed for importation of technology, while Section 8 deals with local research and development (R&D) efforts. In order to complete the scenario of hardware production, a brief comment on software development is included in Section 9. The last substantive Section, N° 10, looks briefly at the human resources problems and at the educational approaches applied. Section 11 contains the main conclusions of the study.

4 E.g. the UNIDO programme of work for a World Consultation on the Electronics Industry; OECD Development Center research project on the electronics industry in New Industrialised Countries (NIC'S)

5 See L. Soete, "International diffusion of technology, industrial development and technological leap-frogging", World Development, vol.13 No. 3, March 1985.

1. Production capacities

The size of informatics and components production as well as its relative importance in local electronics sectors, vary significantly among and within the countries considered.

As indicated in Table 1, Singapore and Brazil, followed by the Republic of Korea, are the largest producers of informatics goods among this group of countries⁶. These three states also have the largest output in electronics components, but in this case, led by the Republic of Korea, followed by Singapore and Malaysia. In the manufacture as well as the assembly of semiconductors, in particular, the Republic of Korea is the most advanced country in the developing world.

The size of informatics and components production in these countries is not only significant vis-à-vis the other developing countries (including those considered in this study) but also in international terms. (See Table 2). Singapore and Brazil rank among the ten major producer countries in the informatics field, while the Republic of Korea ranks 12th. However, Singapore and the Republic of Korea basically produce for export markets, while Brazil's exports in the informatics field are only a very minor part of total production.

In overall terms, as a percentage of world informatics production, the participation of the countries considered here is still small. It is around 1,5% each, in the case of Singapore and Brazil, and about 1% for the Republic of Korea. Their share is considerably higher, however, in the field of components, with the two Asian countries jointly accounting for 12,24% of world production of active components and around 5% of passive components⁷. The Brazilian participation is far less significant (1%, and 1,71% respectively) (see Table 3).

The participation of informatics and components production in total domestic electronics production also varies considerably in the eight countries studied here. They represent a significant part (more than a quarter of total electronics output) in Singapore and Brazil for informatics products, and in Malaysia, Indonesia, Singapore and the Republic of Korea for by active components. Informatics and components (passive and active) constitute more than three quarters of electronics production in Singapore. In Malaysia 70,02% of electronics production is accounted for by active components (see Table 4).

6 The already mentioned rapid growth of microcomputer production in the Republic of Korea may, in the short term, change this country's relative position as an informatics producer.

7 This production is mostly based on assembly operations. See Section 2 below.

The cases of Argentina, Mexico and Venezuela present features quite distinct from the other five countries. None of the former group has a significant informatics or components production either in terms of local electronics production or at the international level.

The figures presented in this section indicate that, notwithstanding the recent progress, the role of the selected countries in world informatics production is marginal⁸. In fact, the eight new entrants have not substantially challenged the solid domination of industrialised countries, which control around 94% of world production in the field. As discussed later, the latter's superiority is not reflected merely in production statistics. They also lead the innovation process and control the marketing and distribution channels for the export of informatics goods. Thus, the development of informatics in the countries reviewed is, so far, not only technologically, but also commercially dependent.

On the other hand, the tables presented here show that the selected countries have a more significant participation in electronics components production than in informatics goods. Such a participation is based, nevertheless, principally on the simple assembly of those products, with a strong presence of foreign-owned subsidiaries, as illustrated by the case of Malaysia⁹.

8 The picture does not change very much if Hong Kong and Taiwan are included therein as they account for 0,72% of informatics world production, respectively, according to the same source employed in Tables 1 to 4.

9 In the Republic of Korea, while national firms made considerable investments for semiconductors production, foreign subsidiaries operating in the country are concerned only with semiconductors assembly (see also section. 2 below).

Finally, it is interesting to note the regional differences existing in the areas dealt with here. The Asian countries are, in terms of output and trade balance¹⁰ well ahead of Latin American countries. If in addition to the Republic of Korea, Singapore, India and Malaysia, the two other "tigers" (Hong Kong and the Taiwan Province of China) and other ASEAN countries¹¹ are taken into account, the total output in informatics goods reaches U\$S 4.2 billion and more than U\$S 12 billion in the components area. In Latin America, only Brazil has a comparable level of production in the field of informatics goods¹².

10 See section 4 below

11 Indonesia, Phillipines, and Thailand

12 In contrast, the two Asian continental economies - India and China - have a minor role in informatics production in international terms. India's annual production of microcomputers, for instance, was about 40,000 units in 1988 (information supplied by A. Parthasarathi, Additional Secretary, Ministry of Science and Technology, India, February 1989). A similar number of units has been reported for China.

Table 1

Production of informatics goods and of electronics
components in selected countries
US\$ million

	Informatics	Components passive active	
India (1986)	185	308	155
Malaysia (1986)	69	160	1554
Republic of Korea (1986)	900	1294	1905
Singapore (1986)	1409	1298	1679
Argentina (1983)	64	n.a.	n.a.
Brazil (1986)	1400	892	418
México (1984)	250	n.a.	83*
Venezuela (1987)	100**	n.a.	n.a.

Source: For Asian countries and Brazil, calculations are made by GERDIC on the bases of Mackintosh Yearbook, Electronics Data 1987, Benn Electronics, Luton 1987, quoted in UNIDO, Estudio global sobre la electrónica mundial, ID/WG.478/2 (SPEC), 3.9.88. For Argentina and Mexico, Interamerican Development Bank, Progreso Económico y Social en América Latina, Informe 1988, Washington, 1988. For Venezuela, Fernando Martínez Móttola, "Electrónica e informática: alternativas para Venezuela", Integración Latinoamericana, INTAL, Buenos Aires, N° 138, septiembre 1988.

* Available data do not discriminate between passive and active components.

n.a.: not available.

Table 2
Major producers of informatics goods
(1986)

	US\$ million
United States	43.773
Japan	19.630
Fed.Rep.of Germany	8.742
United Kingdom	5.461
France	4.129
Italy	3.615
Singapore	1.409
Brazil	1.400
Netherlands	1.491
Canada	1.153
Ireland	1.003
Republic of Korea	900

Major producers of active components
(1986)

	US\$ million
United States	14.900
Japan	12.770
South Korea	1.905
Singapore	1.679
Malaysia	1.544
Fed.Rep.of Germany	1.332
France	1.245
Phillipines	1.103
United Kingdom	1.013
Taiwan	941
Netherlands	572
Italy	484
Brazil	418

Source: Mackintosh Yearbook, op.cit. in Table 1.

Table 3

Production of informatics goods and components
as a percentage of world production
in selected countries (1986)
(%)

	Informatics	Components	
		passive	active
India	0.19	0.59	0.37
Malaysia	0.07	0.31	3.68
Republic of Korea	0.94	2.48	4.54
Singapore	1.47	2.49	4.00
Brazil	1.46	1.71	1.00

Source: Mackintosh Yearbook, op.cit. in table 1.

Table 4

Production of informatics goods and components
as a percentage of total local electronics
production in selected countries (1986)
 (%)

	Informatics	Components	
		passive	active
India	7.16	11.92	6.80
Malaysia	3.13	7.26	70.02
Singapore	25.17	23.19	29.99
Republic of Korea	11.50	16.50	24.33
Argentina	12.50	n.a.	n.a.
Brazil	27.21	17.34	8.12

Source: Mackintosh Yearbook, op.cit. in Table 1, and
 Interamerican Development Bank, op. cit., for Argentina.

2. Productive patterns

The figures mentioned in the previous section do not tell very much, as suggested before, about the productive patterns prevailing in the countries considered. In fact, important differences can be identified in the levels of domestic and technological content involved.

In most of the eight countries, the development of the electronics industry has been based on assembly techniques and low domestic value-added. Components production is a typical case. It has largely concentrated on the assembly of imported parts by low cost -especially female- labour, with very little impact on the creation of endogenous industrial and technological capabilities. The same is true in general, of the production of informatics goods, including microcomputers. Even in the case of countries with outstanding performances, such as the Republic of South Korea, the industry structure shows a marked imbalance. Despite a significant production of semiconductors in the Republic of Korea most of the semiconductors' domestic demand for informatics and electronics products is met by imports. In turn, 85% of semiconductors' local production is exported.

If it is true that mere assembly has, to a large extent, characterised the electronics industries in developing countries, it would be incorrect to depict in this way the current situation in the countries selected for this study. On the one side, some of them have made considerable efforts since the last decade to develop local sourcing of certain parts and components and to foster a "learning by doing" process. On the other, new developments are taking place in several of the developing countries towards greater production integration, even in technologically complex areas such as semiconductors.

The objectives of the national electronics policy in India have included "to achieve technological self-reliance (not in terms of shutting out foreign technology, but in inducing it where necessary and then adapting and developing it appropriately while meeting the technological needs of our strategic electronic products maximally indigenously) to use the technological and industrial capacity built to meet domestic needs, as the springboard for our exports"; and "to strive to realize an electronics industry that is well integrated as between its different subsectors"¹³. The search for local integration, however, does not go beyond some reachable objectives. Indian Government, for instance, allows the import of microprocessors for microcomputers production, on the assumption that it would be unreasonable (due to major economic and technological constraints) to expect local production of such components to take place at present.

¹³ Department of Electronics, Electronics in India in comparison with electronics in the Republic of South Korea, Taiwan, Singapore and Hong Kong, New Delhi, Nov. 1982, p.1-2

In three of the Latin American countries studied here (Argentina, Brazil, Mexico), a peculiar situation has arisen. While the local electronics industry (particularly consumer electronics) is based mainly on low domestic content assembly operations, the national informatics policies have attempted to use the development of a computers and peripherals industry as an opportunity to set up a more integrated local production. In Brazil and Argentina, consumer electronics production is concentrated to a large extent in free trade zones (Manaus and Tierra del Fuego, respectively) where imported parts and components are assembled. In the case of Argentina, in particular, the existence of such a zone has been a powerful disincentive for the development of a more integrated electronics industry. The Mexican case presents similar features due to the activities of "maquiladoras" (assembly firms).

The Brazilian policy seems to have attained some of its goals in terms of a gradual but substantial improvement in the use of local parts and components in informatics production since 1981. In accordance with one study, the "nationalisation" index was 80% for computer peripherals and 95% for microcomputers in 1984. That index would have even reached 98% for nationally developed COBRA 500 minicomputers¹⁴. In Mexico, the goals established by the government in 1981 for local integration were relaxed soon after, in order to ensure competitive prices and promote exports of the internal production. The Argentine experience is too recent to be assessed, but the operation in the country of pure assembly firms and the tariff structure, seem to jeopardise the development of parts and components' local suppliers.

In the case of semiconductors production, the Republic of Korea has made a notable effort to nationalise all stages of manufacture. In 1974 Samsung Semiconductors and Telecommunications Co Ltd. started its first wafer production. It was followed in 1979 by Gold Star Semiconductors Ltd. Currently, there are five wafer fabricators in the Republic of Korea, with an estimated output of US\$ 550 million in 1987¹⁵.

14 See Paulo Bastos Tigre, Industria brasileira de computadores. Perspectivas ate os anos 90, Ed Campus, Rio de Janeiro, 1987, p.71.

15 Samsung will invest US\$ 500 million for completion of its fourth semiconductor plant to make 4MD and 16 MDRAM chips. Hyundai planned a US\$ 385 million investment for a similar purpose. See Financial Times, 24.10.88.

The semiconductors industry is also undertaking a backward integration process in the form of wafer fabrication in Singapore and Malaysia. In Singapore, in effect, recent developments are transforming the industry from the production of simple bipolar integrated circuits to more sophisticated products. SGS/ATES and Hewlett Packard have invested in diffusion units for integrated circuits for mass consumer products and for gallium arsenide circuits, respectively. ATT has invested in a design unit, Unizon (Japan) in a production line for discrete semiconductors and integrated circuits, while a joint-venture (involving National Semiconductors, Sierra Semiconductors and Singapore Technology Corporation) has been set up to establish a U\$S 50 million unit for CMOS integrated circuits¹⁶. In the case of Malaysia, Motorola will produce discrete transistors and INTEL received government authorization to set up a U\$S 100 million microprocessors' manufacturing unit.

The mere assembly, on the one side, and the integration of local parts and components, on the other, are approaches with clear trade-offs. Assembly generally permits production at competitive prices (though that is not necessarily the case) and, hence, facilitates the local diffusion and use of the technology as well as the undertaking of exports. The impact of this approach on employment, labour qualifications, industrial and technological development is generally weak. In contrast, the development of local sourcing would require a certain delinking from the international market, but may assure the creation of a domestically - integrated industry, the upgrading of technological capabilities and more jobs, particularly for qualified personnel. A good part of the recent history of the electronics industry in developing countries reflects, in fact, the tension between these two approaches.

16 See UNIDO, The electronics industry in the Asean countries. Singapore, ID/WG.478/7 (SPEC) 9.9.88.

3. Industrial structure

The dimension and specialisation pattern of enterprises involved in the local production of informatics products and semiconductors present a range of different situations by country and sectors concerned.

Powerful industrial conglomerates dominate the electronics industry in the Republic of Korea. In particular, Samsung, Goldstar, Hyundai and Deewoo Group account for about 50% of microcomputers production and for 100% of semiconductors' wafer fabrication. Their large financial resources, the learning process made in the field of consumer electronics, the setting up of a R&D infrastructure and the exploitation of economies of scale, are among those big firms' advantages to operate in new high-technology fields.

In India, the electronics industry is also heavily centered around large firms. As far as microcomputers are concerned, four major producers (HCL, Sterling, Wipro and Eiko) dominate the market. In the field of main-frames and of minicomputers, ECIL and International Computers Ltd. (ICL-India) are the major players. The top ten manufacturers account for 80% of the output in the computers market, while the remaining 20% is accounted for by 70 small units mostly engaged in assembly activities.

Two main differences between the Indian and the South Korean cases can be mentioned. First, in India the most important enterprises in the field are public-owned. However, the predominance of public sector firms does not exclude, as indicated, the participation of foreign and national private firms, including smaller size enterprise. ICL is the computer company with the largest turnover (RS. 29 crores in 1986). A handful of private Indian firms also produce minicomputers¹⁷. Second, the Indian firms are mainly specialised in the manufacture of various types of electronics equipment, and do not cover such a wide range of products as the South Korean conglomerates do. These large integrated corporations are best positioned to finance the high investments required to compete internationally and to enter into new and capital intensive fields, such as semiconductors production.

The computer industry established in the Latin American countries considered here also follows a specialisation pattern. Small and medium enterprises are predominant in Argentina, Mexico and Venezuela. In Argentina, the average number of employees per firm was 110 persons in 1983¹⁸. The eleven firms that obtained promotional incentives for computer production in the country, planned a total investment of about US\$ 40 million and a total employment of 3.700 persons by 1992.

17 See Ashok Parthasarathi, "Informatics for development: The Indian experience": paper prepared for the 2nd Session of the North-South Round table of the Society for International Development, Tokyo, October 1-3, 1987.

18 Inter-American Development Bank, op.cit. p.128.

In Mexico, the expansion of the domestic market allowed the emergence of about one hundred micro and minicomputers and peripherals producers, which had created 6000 jobs by 1987. 71% of the enterprises operate in the field of microcomputers and peripherals. Due to its low level of automation and equipment investment, nevertheless, they only account for 23% of total fixed assets¹⁹. In the case of Venezuela, over one hundred enterprises participate in a US\$ 100 million market of "professional" electronics goods (telecommunications, industrial control, data processing and components)²⁰.

In the Brazilian case, more than 200 firms produced computers and peripherals in 1987. A number of large firms --at least in terms of the country's industrial structure-- have emerged in the framework of the "market reservation" policy applied there. While IBM and Unisys are the major actors, both in terms of aggregate sales and employment, in the field of microcomputers, minicomputers and peripherals five national firms had each more than one thousand employees in 1985. The growing competition that characterised those markets, has led to a significant decline in the level of concentration since 1979. The five top firms controlled 88,8% of the market in that year, but only 47,4% in 1984²¹.

It is also interesting to note that out of the ten major national informatics firms, five (Itautec, Cobra, SID, Labo and Edisa) are directly or indirectly controlled by large financial institutions. The informatisation process undertaken by these institutions was an important component of the demand of equipment manufactured by the controlled informatics enterprises.

19 See Ricardo Zermeño González, "La industria de cómputo en México: situación actual y perspectivas", México, 1988.

20 See Fernando Martinex Móttola, op.cit.

21 See Paulo Bastos Tigre, op.cit.p.68. If the ten major national firms are considered, the respective figures are 98% and 67,5%.

4. Internal and export markets

One major difference in the electronics development approaches followed in the countries selected for this study, relates to the role played by domestic and export demand. Two very clear models have been applied. India, Argentina and Brazil have emphasised production for the domestic market. Import substitution has been one of the main objectives, in particular, of the informatics policies implemented in those countries during this decade. In contrast, the Republic of Korea, Singapore, Malaysia and -to some extent - Mexico, have opted for an export-oriented model.

The Brazilian and Indian policies are good examples of the first approach. The exploitation of their large internal markets has been considered the basis for industry's development. The Brazilian computer market exceeds US\$ 3 billion annually. It is clearly the biggest market in Latin America and, currently, largely exceeds those of other continental economies in the Third world. The estimated value of computer systems sold in India was RS 280 crores in 1986²². However, the potential growth of the market, as shown by the escalating sales of microcomputers, is still considerable.

Notwithstanding the relatively small dimension of the Argentine computer market, the national policy designed in 1984 also emphasised development for the internal market, as the first step in the building up of a national industry. Exports requirements for the granting of promotional incentives were considerably low (about 7% of production). In Argentina (as well as in Brazil) most exports in the informatics field are accounted for by transnational corporations (particularly IBM). National firms are very marginally interested or involved, so far, in export activities.

In contrast, almost 90% of microcomputers production of the Republic of Korea and a large part of peripherals are exported, mainly to United States and Japan. Most exports take place on an OEM basis²³. Under that scheme IBM has been supplied with monitors and banking terminals, Amstrad with computers and Texas Instruments with semiconductors. The success obtained²⁴ shows the quality and cost-efficiency achieved by the industry in large-scale production. Nevertheless, the predominance of the OEM modality is an indicator of a substantial weakness in marketing abilities. In fact, the country's firms have failed till now to establish their own brand names in export markets.

22 Approximately US\$ 280 (at the average rate over the 1980's)

23 An "Original Equipment Manufacture" (OEM) relationship takes place when a firm contracts the production, under its own brand name, of determined products.

24 According to data of the Electronic Industries Association of Korea, exports of computer hardware and parts totalled US\$ 1,3 billion in 1987.

The experience of the Republic of Korea in informatics constitutes a good example of an export-led industrial development in a country with a limited domestic market. The small size of such a market forced local firms to seek mainly foreign buyers. The export oriented approach has been combined with strong import barriers²⁵. Only recently, as a result of United States and European demands, a process of liberalisation has been implemented that gradually reached different informatics products. The experience of the Republic of Korea seems to show that the existence of an open domestic market is not a precondition to become competitive at the international level, as often argued by the opponents of national policies based on the protection of incipient industries in high technology fields.

In the case of Singapore more than 85% of the country's electronic production is exported (60% of it to the United States). Office equipment and informatics products (particularly computer peripherals) increased their share in total electronics exports from 6% to 46% between 1980 and 1987, while that of components fell from 43% to 25%²⁶. The role of transnational corporations in such exports is considerable. In Malaysia, likewise, almost 90% of electronics production -mostly controlled by foreign-owned industry- is exported. The largest part of such production (about 85%) corresponds to semiconductors.

The export performance of Singapore and the Republic of Korea is illustrated by their share in the markets of United States and Japan. The former has become the largest source of imports to the United States, in peripherals and parts, and the latter plays a similar role -but with quite lower values- in Japan. United States imports of automatic data processing equipment and parts from Singapore reached more than US\$ 4 billion between 1985 and 1987 and exceeded US\$ 1 billion in the case of the Republic of Korea in the same period (see Figure 1).

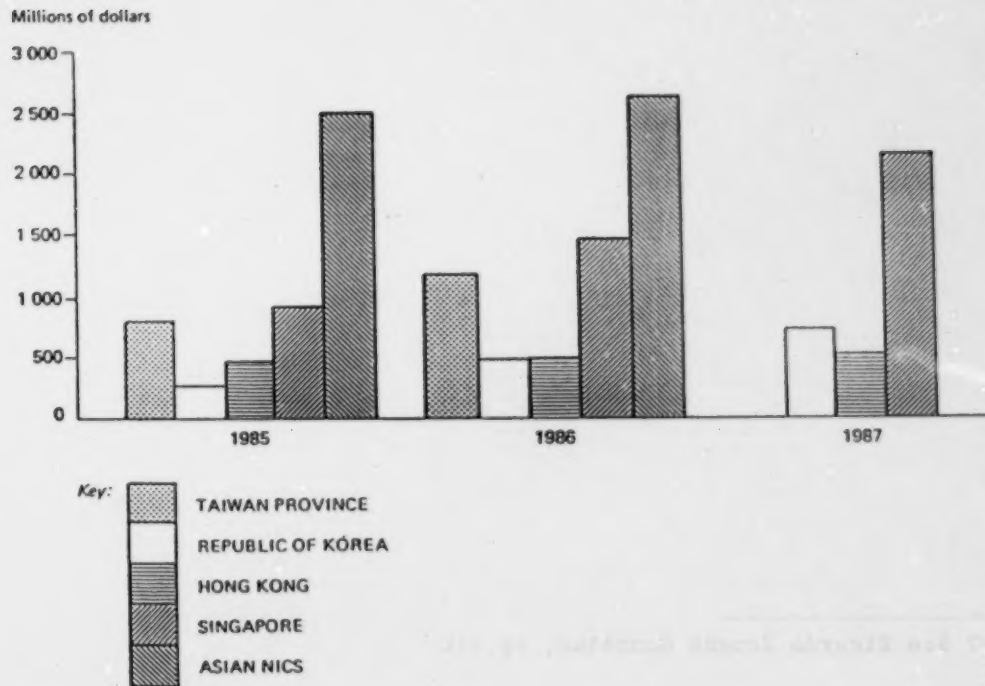
The informatics policy designed by the Mexican government also emphasised the setting up of a competitive industry and the expansion of exports. The participation of foreign companies in the governmental programme has been viewed as one of the means to attain such objectives. Between 1983 and 1987 exports of informatics products increased at a 127% annual rate. The exports-imports ratio dramatically increased from 1,6% to 68%. Imports also reflected a substantial growth of parts and

25 Restrictions have included limitations for foreign companies to import (and distribute) their own products.

26 See UNIDO, ID/WG.478/7(SPEC), op.cit.p.18

Figure 1

USA COMPUTER PRODUCTS TRADE PROFILE - 5
TOTAL (752 + 7599) - IMPORTS FROM SOUTHEAST ASIA



Source: United Nations Trade Statistics

components (from 9% to 45% of total imports of informatics goods between 1981 and 1987)²⁷.

More generally, table 5 indicates the 1986 trade balance in informatics goods and components of some of the selected countries considered here. It confirms the impressive results of the export-oriented scheme in Singapore and South Korea not only in the informatics field, but also in components (particularly active) as well as the importance of Malaysian exports of locally assembled active components. As for countries with an import substitution strategy, it is interesting to note that while India shows a deficit in both subsectors, Brazil has managed to obtain a modest surplus in informatics products as well as in components.

27 See Ricardo Zemeño González, *op.cit.*

Table 5

Trade balance in informatics products and
components in selected countries
(US\$ million)

	Informatics	Components	
		passive	active
India	- 41	- 71	- 144
Malaysia	- 96	- 97	1457
the Republic of Korea	230	178	1049
Singapore	668	366	1410
Brazil	100	92	- 76

Source: Mackintosh Yearbook, op.cit. in Table 1

5. State's role in industry development

The history and present situation of the electronics industry are closely linked to the State's direct or indirect intervention, on the one side, and to the activities of large transnational corporations, on the other. The experiences of the countries reviewed in this report present a wide variety of schemes under which the relationships among States, transnational corporations and other firms are organised²⁸.

State intervention has been prominent, in particular, in the industrial strategies in informatics and semiconductors in India, and Brazil. In addition to providing the general framework and support for industrial development, the State undertook productive activities. In India, the public sector company ECIL, for instance, since 1969 manufactured computer systems ranging from 8 bit and 16 bit systems and supplied them to over 200 installations in the country. ECIL is engaged in hardware design, software development, manufacturing, marketing and maintenance, including the 32 bit computer 'System 332' developed and manufactured indigenously²⁹.

Two State owned firms -Bharat Electronics Ltd. (BEL) and Semiconductor Complex Ltd. (SCL)- produce integrated circuits in India. The BEL facility is vertically integrated in terms of CAD and mask production. In 1984, the company decided to manufacture microprocessors and memory chips using RCA technology. SCL has focused on the supply of modules and electronic circuit blocks for watches and clocks assembled in India, among other items³⁰.

In the case of Brazil, the federal government enterprise for computer services SERPRO initiated the production of computer hardware in 1970. These productive activities were later on transferred to the State company COBRA which developed terminals and minicomputers for internal commercialisation. On the basis of the "COBRA 500" minicomputer launched in 1980, the enterprise became the leading computer firm in that segment in Brazil. In 1981 it had made around half of all minicomputer installations and accounted for one third of total sales in the domestic market³¹.

28 See also section 6 below

29 UNIDO, IS, 492 op. cit. p.42.

30 See C. Edquist and S. Jacobsson, "The integrated circuits industries of India and the Republic of Korea in an international techno-economic context", Industry and Development, No 21, UNIDO p.44-45

31 See Paulo Bastos Tigre, Computadores Brasileiros. Industria, Tecnologia e dependencia, Ed. Campus, Rio de Janeiro, 1984.

Certainly, the definition by Indian and Brazilian governments of the basic parameters of the informatics policies, has been decisive in framing the patterns of industrial and technological development in that sector. In both cases, informatics has been regarded as strategic for the country's autonomy and not only in terms of new market opportunities.

The government's role has also been significant in other countries, such as Argentina, Mexico, the Republic of Korea and Singapore, but its action has not involved direct production. Support of R&D activities, granting of fiscal incentives and national buying policies, are among the instruments most frequently applied to foster national development in this field³².

Fiscal incentives have been accorded to nationally owned enterprises under Brazilian law 7232, for hardware, components and software production. They usually take the form of tax exemptions and access to financial support. In Argentina, likewise, Decree 652 (1986) provided for various tax exemptions for enterprises that committed themselves to certain levels of production, R&D and integration of local parts and components. The benefits also included special tariff rebates for the importation of necessary parts and components for limited periods.

32 For government support to R&D activities, see point 8 below.

In Mexico, the government informatics policy of 1981 also provided for fiscal incentives, financial support for new investments, export incentives and facilities to acquire components and subassemblies from "maquila" firms.

The Government of the Republic of Korea has been largely involved in supporting the development of the electronics industry. Currently, for instance, tax and financial measures have been adopted to help local firms to face appreciation of the won and the impact of trade liberalisation policies.

The Government of Singapore developed a set of incentives and support mechanisms accessible to both local and foreign electronics enterprises. Governmental support was, in contrast, less pronounced in Malaysia. However, the 1986 Promotion of Investment Act contemplates, incentives and tax holidays for a wide range of electronics products.

National buying policies have been used to different degrees to create internal demand for informatics products in several countries reviewed here (e.g. Argentina, Brazil, Mexico, the Republic of Korea). Hardware acquisitions by public agencies constitute, in some cases, an important component of domestic demand. In Mexico, for instance, after the nationalisation of banking entities, such agencies account for more than half of the internal computers' demand. Programmes for the introduction of informatics in schools have also been conceived to promote local production, among other objectives. The acquisition of 5000 8 bit computers by the Government of the Republic of Korea was, in that sense, at the inception of the computer industry in that country. Local production has also been targeted in programmes established in Argentina and Mexico³³.

33 Mexican "Microsep program", for instance, is based on the supply of locally assembled 8 bit microcomputers. The Argentine government has recently contracted with a national firm the design and development of an equipment for educational purpose, to be domestically produced.

6. Foreign participation

The role of foreign direct investments -and particularly of transnational corporations- in the countries and sectors considered in this report fall into different patterns. While in all selected countries some form of foreign capital participation is allowed, the extent and modalities thereof vary significantly. Three main situations may be observed, as described below.

In some countries foreign direct investments have been actively promoted and play a major role in the production of informatics goods and semiconductors. A typical case is that of Malaysia, where foreign-owned subsidiaries -mostly from United States- account for the largest part of production, particularly in the semiconductors field. Singapore, likewise, is the ASEAN country which is most open to foreign industrial investments. 64 out of 104 firms in the area of components, and 16 out of 25 in industrial electronics are of foreign origin³⁴.

At the other extreme, India and Brazil have set forth strict rules for foreign direct investments participation. In India, in particular, a policy aimed at limiting the operation of foreign wholly-owned subsidiaries and requiring the establishment of joint-ventures with local partners caused IBM to leave the country at the end of the last decade. That policy, however, did not prevent some firms, such as International Computers Ltd (ICL-India), to actively participate in the expanding Indian market. Recently, a number of joint ventures have been negotiated with Control Data Corporation, Digital Equipment Corporation, Data General, Olivetti and Tolerant for the manufacture of mainframes, super-minicomputers and other equipment³⁵.

The informatics policy in Brazil has been structured on the principle of "market reservation" for local firms. This principle means that neither imports nor foreign direct investments are permitted in certain reserved segments of the market. These include minicomputers, microcomputers and peripherals. According to the "Informatics law" No 7232 of 1984, foreign participation in those areas is only permitted up to 30% of the enterprise's capital, provided that the effective control of its operation remains in local partners' hands. Although the exclusion referred to has created friction with United States, it has not prevented American firms from benefitting from the notable expansion of the Brazilian informatics market. IBM Brazil is, in fact, the largest company in the country both by sales and by number of employees³⁶.

34 See UNIDO, ID/WG.478/7 (SPEC), op. vii., p. 30.

35 See Ashok Parthasarathi, op. cit. p. 3.

36 IBM Brazil turnover was, in 1985, seven times higher than than of the second top firm (Burroughs) and was the largest employer in the sector (with 5000 employees, IBM is followed by COBRA with 2700). See Balanco Anual Gazeta Mercantil, 1986.

Finally, in a third group of countries, the situation is not as clear cut as in those referred to before. In Argentina, the informatics policy established in 1984 promoted the establishment of joint-ventures with foreign firms (Burroughs and Bull associated, as a result, with private local firms). Though no written rule was adopted, wholly-owned foreign subsidiaries were not considered an appropriate means to enhance the local absorption and development of technology. In Mexico, the policy announced in 1981 - but never formalised - was also based on the establishment of joint ventures and the refusal of wholly-owned subsidiaries. However, after a long debate and in the context of a substantial change in the overall foreign investment policy, a hundred percent investment by IBM for microcomputers manufacture was accepted. In Venezuela, likewise, amendments to the foreign investments regulation have relaxed authorization procedures in the informatics field³⁷. However, no substantial foreign investments have taken place so far in that field. Finally, in the case of the Republic of Korea, the Government has also significantly intervened to orient foreign direct investment and to set up the conditions for the participation of foreign firms.

The various approaches followed reflect different perceptions on the advantages and disadvantages that the participation of transnational corporations may carry out. Countries concerned with building up indigenous industrial and technological capabilities in the framework of long-term self-reliance objectives, have viewed such a participation as a serious potential risk. The marketing power and technological superiority of transnational corporations can, in fact, create insurmountable barriers to set up new national enterprises, if these are forced to compete in an open market with the former. In addition, such corporations are reluctant to transfer technology to and to localise R&D activities in developing countries. Hence, the operations of foreign subsidiaries generally have a low technological impact. Their contribution, in particular, to the upgrading of local design and engineering capabilities is generally weak, although they may help to improve the quality standards of local suppliers and to train certain kinds of labour (mainly for assembly and eventually testing tasks).

In some countries (e.g. Brazil), even the role of joint-ventures between national partners and transnational corporations has been regarded unfavourably. On the one side, it is feared that the asymmetry of effective commercial, financial and technological power between the partners could lead sooner or later to a subordinated role for the local party. On the other, in order to undertake a local learning process and attain a certain self-reliance, it is necessary to strongly involve national professionals and entrepreneurs.

37 Decree 1200/86 on foreign direct investments and transfer of technology, 1986.

In contrast, other strategies have tried to rely on transnational corporations' productive or marketing abilities, particularly in order to generate exports. In the Mexican case, for instance, it was clear that a significant trade off existed between the acceptance of foreign direct investments to promote exports and other national objectives, such as an indigenous technological development in the field, the creation of stronger linkages with local suppliers, and the establishment of areas of reserved markets for national production. In the case of the Republic of Korea, instead, the relationships with transnational corporations under OEM agreements, aim at taking advantage of the latter's marketing capabilities, rather than of their productive strength. The specifications communicated under those agreements have also helped the industry to improve design and engineering capabilities.

7. Technology transfer

The development of the informatics and semiconductors industries in developing countries, in general, and in those countries considered here, in particular, has been based to a great extent on the transfer of foreign technology through licenses and similar arrangements. Different situations, however, have arisen depending upon the nature of the industrial activities undertaken and the firms' and government's strategies.

In the field of semiconductors, assembly operations made in the Republic of Korea, Malaysia and other countries by transnational corporations have not encompassed any significant transfer of know-how. Assembly utilizes technology almost exclusively embodied in imported capital goods. The assembly operator requires little training to reach peak efficiency and acquires few generalizable skills³⁸.

When the Republic of Korea and India initiated manufacturing activities of integrated circuits, however, they were able to obtain licenses from foreign sources. In 1983 Samsung Semiconductors and Telecommunications Co. Ltd. made an agreement to introduce 16K static random access memory (SRAM) and 256K ROM from Sharp in Japan. In the same year it established a firm in California for the purpose of technology absorption and design of ICs, and made an agreement with MICRON of the United States to produce 64K and 256K DRAM³⁹.

Gold Star Semiconductors Ltd. began to work on 8-bit microprocessors under license from Zilog in 1983, and on CMOS technology under an agreement with LSI Logic. During the last five years the number of licenses and royalty payments in the semiconductors industry increased considerably in South Korea. The main sources of technology have been firms from United States and to a minor extent from Japan.

In India, Bharat Electronics Ltd. entered into a collaboration agreement on CMOS technologies with RCA. Semiconductor Complex Ltd. did the same with American Microsystems Inc. for LSI circuits.

On the basis of the imported technology, the recipient firms undertook a learning process which apparently allowed them to autonomously envisage new technological steps. For instance, while Samsung Semiconductors and Telecommunications started production of 256 K DRAM on the basis of an imported design, it claimed to have built up the process itself. Indian Semiconductor Complex Ltd. developed in house 3-micron CMOS and NMOS technology, although it had the option to obtain it under an agreement entered into with American Microsystems⁴⁰.

38 See UNCTC, Transnational Corporations in the International Semiconductor Industry, New York, 1986, p.XXV

39 See C. Edquist and S. Jacobsson, op. cit., p. 28.

40 Idem p. 28

There are two interesting features in connection with the experience of the Republic of Korea. On the one side, licensing increased at the same time that local research and development expanded considerably. The latter was not, hence, an alternative but a complementary tool aimed basically at improving the capabilities for selecting and negotiating foreign technologies and enhancing product development. On the other, the four large conglomerates (Samsung, Goldstar, Hyundai, Daewoo) decided to establish foreign research subsidiaries, particularly in the United States, in order to ensure access to new technological developments. That is the case, for instance, of Goldstar with United Microtek and of Daewoo with Zymos (in the latter case for CMOS technology for application specific integrated circuits - ASIC's).

In the informatics field, licensing has also played an important role in the creation of minicomputer production in Brazil and India. The first stage of the Brazilian informatics industry, for instance, was closely linked to the establishment of licensing agreements with various foreign firms (the first one with Ferranti in 1974). Until 1981, eighteen agreements had been entered into by fourteen national firms and sixteen foreign licensors. Most recipient firms viewed such agreements as an important tool to foster the development of local technological capabilities⁴¹.

The standardisation that took place in the area of microcomputers allowed many firms to enter into that dynamic market through "reverse engineering" and "emulation" of foreign products. PC "clones" produced in Asia accounted for 8,3% of world PC market in 1987⁴². The Republic of Korea and Singapore have excelled in the production of high volumes of computer peripherals⁴³. Numerous firms in Brazil, Mexico, Argentina and Venezuela and Malaysia assemble microcomputers and peripherals as well, though mainly for the domestic market.

Even in the case of the most successful countries, like the Republic of Korea, the dependence on foreign designs and on imported components for microcomputers production is still high. Though in South Korea, Brazil and other countries production of 80386 32 bit machines has already started, the impact of new leading firms' strategies aimed at reducing the imitation of their machines is still an open question⁴⁴.

41 Paulo Bastos Tigre, Computadores brasileiros, Industria, Tecnologia e Dependencia, Rio de Janeiro, Ed., Campus, 1985, p. 151.

42 Data from Intelligent Electron Dataquest.

43 Peripherals account for the largest part of informatics production and exports in both countries.

44 With the introduction of the IBM PS/2 with a veiled architecture and the threat of legal suits for "piracy", for instance, the scenario for clones' production may be altered in the future.

The governments' attitudes in connection with the transfer of technology vary among different countries and over time. In most of them (South Korea, India, Argentina, Mexico, Venezuela) transfer of technology agreements have been subject to prior authorization or registration, in order to limit royalty payments abroad, avoid restrictive practices, ensure the granting of appropriate guarantees, promote the compatibility of the technology to be transferred with national needs and conditions, exclude the licensing of trademarks not linked to an effective transfer of know how, and / or enhance the assimilation of foreign technologies. In the framework of a process of liberalisation of foreign direct investments and technology transfer regulations that involved a large number of developing countries, those countries mentioned before introduced during this decade important changes in their regulations or administrative practices, that considerably relaxed controls. Argentine policy in the field, for instance, was liberalised in 1981; the same occurred in the Republic of Korea in 1984 and 1988⁴⁵, and in Venezuela in 1986. In the latter case, the new regulation (Decree 1200/86) provided for a special treatment for technology transfer contracts relating to high technology fields.

Unlike the countries just mentioned, Brazilian technology transfer policy has been maintained without substantial changes during this decade. In the field of informatics, in particular, licensing has been viewed as a first step to obtain the knowledge necessary to enter into new fields. The contracts, however, must be limited in time and not renewable, in order to stimulate the local recipient firm to assimilate the technology and become independent of the supplier in a short time.

In addition to the formal means of acquiring technology abroad, in some of the countries dealt with informal mechanisms therefore have had great importance. The overseas education and training of scientists and engineers (particularly in the United States) was critical for Korean development at the technical and managerial levels. The government was successful in the implementation of a scheme to bring back over 1200 scientists and engineers since 1968⁴⁶. Other countries affected by important brain drain, like Argentina, have not been so successful in their attempts to recover their professionals trained abroad.

45 The approval system was replaced by one of simple registration

46 See Ministry of Science and Technology, "Introduction to Science and Technology", Republic of South Korea, 1987. A plan for training of South Korean graduates overseas was implemented since the sixties. In 1965, around 90% of graduates were sent abroad for that purpose.

8. Research and development activities

It is difficult to assess the extent and composition of R&D activities undertaken in the countries under consideration. Not surprisingly, two of the countries with largest production in the fields dealt with here, Brazil and the Republic of Korea, are the most relatively advanced in terms of R&D infrastructure at the public and private level. In India there are also a number of enterprises (e.g. Bharat Electronics Ltd., Semiconductor Complex Ltd.) and organisations with considerable R&D activities. In Singapore, an important increase in R&D expenditures as a percentage of GNP has taken place during this decade (from 0,6% in 1985 to an estimated 1% in 1988)/. The weight of foreign direct investments in the electronics field, and its very limited role in R&D, in part explain Singapore's handicaps in that area.

In Argentina, Mexico and Venezuela some efforts have been made in the 1980's in order to widen the R&D infrastructure in the area. The overall expenditures, however, are limited. So are the number and qualifications of available researchers.

A major difference among the countries that have advanced further creating a R&D infrastructure in informatics and semiconductors and the others, is the extent of industry participation in that effort. In the Republic of Korea, for instance, about 30% of total R&D expenditure in those sectors is accounted for by private firms. The willingness to reinforce the capabilities for appropriately selecting, assimilating and adapting foreign technologies and the fears about growing difficulties to obtain access to them, stimulated national firms, particularly the big conglomerates with activities in the field, to invest in R&D facilities since the last decade. Samsung, GoldStar, Daewoo and Hyundai have made significant investments in the area, as illustrated by the setting up of the Samsung Advanced Institute of Technology (considered one of the largest in the country). As mentioned before, actions taken by those enterprises have included the establishment of research facilities abroad, especially in the United States. In the case of Brazil, likewise, it is estimated that national informatics firms devote 6% of their sales to R&D. In terms of employment of professionals for hardware/software development, national firms accounted for 189 professionals per US\$ 100 million in sales, while the ratio for multinational firms was only 19 (estimated data for 1986)/.

47 See UNIDO, ID/WG. 478/7 (SPEC), op. cit., p.37.

48 See Secretaria Especial de Informática, Panorama do setor de informática, Bol. Inf. V.7, No. 16, August 1987, p. 14.

In most of the countries considered the government has played an important role either by promoting R&D in the field or by executing it in public laboratories. In India, for instance, several institutions have strengths of varying levels in some or all aspects of microelectronics technology, such as the Central Electronics Engineering Research Institute, the Tata Institute of Fundamental Research, Indian Telephone Industries, and the Indian Institutes of Technology at Delhi, Kanpur, Kharagpur, Madras and Bombay. In the Republic of Korea, the government set up the Korea Institute of Science and Technology (KIST) in 1966, later transformed (with the merger of KAIS) into the Advanced Institute of Science and Technology (KAIST). In the specific fields dealt with here, the Electronics and Telecommunications Research Institute is active in the development and commercialisation of technologies. Research projects include the development of 4M DRAM and gallium arsenide semiconductors. The Government has also provided financial support for R&D undertaken at the firm level. Currently, emphasis is given to promote R&D in small and medium enterprises.

In Singapore, a Science Park was established in 1979, conceived in the image of the Cambridge Science Park. The National Computer Board and many R&D establishments have been set up there, including twenty nine private organisations which occupy either "starter units" or "Cintechs" (in the case of software activities)⁴⁹. A Science Park is also being established in Malaysia, where a semiconductor research institute would be localised there by 1990. The Malaysian Institute of Microelectronics Systems -created in 1984 by the Government- promotes product development and research. It has entered into various collaborative research projects involving foreign subsidiaries operating in the country.

Several governmental institutions undertake R&D activities in informatics and/or microelectronics in the Latin American countries reviewed in this report. Among them, the Centro de Tecnología Informática -which is setting up a mask fabric for integrated circuits-, the laboratory of the State enterprise Telebras, and the Federal University of Rio de Janeiro may be cited in Brazil. In Argentina, various national universities and other institutions execute projects of different nature. The government also provides funds and a framework for the relationship with private enterprises under the National Program of Informatics and Electronics. In Mexico CONACYT finances R&D projects, in addition to those covered by universities and other public entities⁵⁰. Finally, in Venezuela, among other institutions, the Engineering Research Foundation works on integrated circuits design and other areas of electronics and system engineering. It has a centre for digital imaging processing build up as a joint-venture by the Foundation, the Venezuelan Institute for Scientific Research (IVIC), the Central Office for Statistics and Informatics (OCEI) and IBM.

49 See UNIDO, ID/WG. 478/7(SPEC), op. cit., p. 37.

50 As a result of the negotiation that took place in order to allow a one hundred percent investment by IBM, a design center is to be established at the Politécnico of Mexico, with an investment exceeding US\$ 5 million.

The perception of funding and human resources limitations for R&D in the Latin American countries and areas considered here, has prompted the establishment of cooperation agreements, such as the joint research project "ETHOS" agreed upon and in execution since 1985 between Argentina and Brazil⁵¹.

Some forms of indirect governmental support for R&D has also been practised in those countries to different degrees. In the case of Brazil, in particular, Law 7232 contemplates the granting of incentives to national enterprises that undertake research for the production of semiconductors and optoelectronics components. In addition, the Financiadora de Estudos e Projetos (FINEP) financed about sixty projects between 1973 and 1983 in the area of informatics, which were in part executed by the Federal University of Rio de Janeiro and the State-owned enterprise COBRA.

51 See Carlos M. Correa, Tecnología y desarrollo de la informática en el contexto Norte-Sur, Ed. Eudeba, 1989.

9. Software development⁵²

Studies on the size and structure of software markets in developing countries are scarce. Overall, developing countries are largely dependent on hardware and software imports. The latter include mainly basic software, application tools and other types of packaged software. Some countries also import custom software, particularly for public administration projects. However, applications such as those for administrative and accountancy tasks, are generally developed by local firms. In a few cases (e.g. Brazil, India) the development of basic software, including operating systems, has been envisaged by public and private enterprises⁵³.

Locally developed software accounts for a minor part of the market in the Latin American countries considered in this report. In Argentina, a survey established that only 30% of the market (in value) was covered by local production⁵⁴. That proportion was about 40-45% in Mexico for 1987, according to official estimates. For Brazil, a recent estimate indicates that only a quarter of the total market is provided for by local software producers (in-house development excluded)⁵⁵. In Venezuela, finally, local software industry is also incipient and basically limited to the supply of application solution programmes.

52 This section is substantially based on a first draft of Carlos M. Correa, "The legal protection of software. Implications for latecomer strategies in newly industrialising countries and middle-income countries," paper prepared for the OECD Development Center, 1989.

53 In Brazil, for instance, an operating system for minicomputers and systems-like MS-DOS and UNIX has been developed by national enterprises. The government of India has also promoted the local development of a substitute for UNIX.

54 Subsecretaria de Informática y Desarrollo, "Producción y comercio de software en la Argentina", doc. No. 35, Buenos Aires, 1987.

55 See C. Pereira Lucena, 1988, "A tecnologia de software no Brasil: a caminho de uma participacao no mercado internacional", paper prepared for the Centro de Estudos em Politica Cientifica'e Tecnologica do Ministerio de Ciencia e Tecnologia, 1988

The situation in Asia, even in those developing countries which have created important capabilities in hardware manufacture, does not substantially differ in general terms from the one depicted for Latin America. Although 71% of the Republic of Korea's software supply is accounted for by local firms, software imports are growing fast (at an annual 101% rate between 1983 and 1985) and local suppliers have a low level of specialization and of technical capabilities⁵⁶. Some countries have made, nevertheless, significant efforts to increase domestic software production and, particularly, to develop export opportunities. The best known example is India. As early as 1970 the Indian Government devised policy measures in order to expand software exports, on the basis of perceived comparative advantages in terms of personnel costs and qualifications and the use of the English language. The very ambitious objectives set forth, however, were not achieved after fifteen years of application of those measures. In 1986 the policy was changed -and liberalised-, while some arrangements with transnational corporations (Burroughs, Texas Instruments) started to produce some results. In the financial year 1987-88 exports for RS. 80 crore were attained. "But of course," pointed out the Secretary of the Department of Electronics, "a significant part of it is in people (manpower) exports or body shopping or whatever". The establishment of "software technology parks" in India, with direct satellite link with companies in United States is currently being promoted⁵⁷.

Singapore also put into practice in 1982 a policy, including the granting of subsidies and the establishment jointly with transnational corporations (IBM, ICL, NEC) of training centres and research projects, in order to become a software exporter by 1990. Bull and Data General Corporation have also undertaken software activities. The latter, in particular, decided a US\$ 42 million investment (over five years) to set up a software centre. The development of software engineering tools (CASE) by a Singapore firm (which has opened a subsidiary in the United States) has been recently reported⁵⁸.

Isolated cases of software exports have been identified in Argentina, Brazil, Venezuela and Mexico. The number of cases identified, the nature of the products involved and the economic dimension of the operations made do not justify, nevertheless, the optimism that prevails in Latin America on the opportunities offered by software industry.

⁵⁶ See UNIDO , Software industry: development approach (by S. Yu and Y. Kim), ID/WG.478/1 (SPEC), 1988, p.52-53

⁵⁷ Computers Today, September, 1988, p. 11

⁵⁸ American Programmer, vol. 1, No. 7, September, 1988 p. 1.

Software production has been identified, in fact, as a promising field of action in many developing countries. While, it is argued, newcomers face high barriers for entering into the production of hardware, with low capital investment and the mobilisation of local qualified personnel it is relatively easy to exploit the growth potential of the software sector. Paradoxically, up to now a few NIC's have evidenced, as described above, their ability to successfully enter into some segments of hardware production and international trade, while the efforts made to establish software capabilities have not had, at least up to now, significant results.

Among the major obstacles faced by developing countries to enter into the software field, are the dimension of the domestic market, the present structure of local supply and the weakness of marketing capabilities.

Estimations for market size in Latin American countries indicate about U\$S 150 million for Argentina⁵⁹ and Mexico⁶⁰, and U\$S 700 million for Brazil⁶¹. The software market of the Republic of Korea was roughly estimated to be U\$S 76 million in 1985, growing at an annual rate of about 52% since 1983⁶².

The structure of software local supply in those countries -for which information is available- invariably indicate a considerable fragmentation and the predominance of small enterprises. In the Republic of the Republic of Korea, for instance, about 1,000 firms have been identified, almost half of which have less than fifteen employees. In Argentina, similarly, 82% of more than 120 firms selling software have less than ten employees. In both cases, investments in equipment and software tools are considerably low. Similar characteristics of software supply have been observed in Venezuela.

Finally, as mentioned before, in most cases local "software houses" in the countries under consideration concentrate on relatively simple, custom made, application software and lack technical capabilities as well as capital to undertake larger software development projects, and particularly standard software. Moreover, even in those cases where technical competence is available, the marketing of software in export markets is an extremely difficult task, unless joint-ventures and other types of partnerships are established.

59 Network, Año 1, No. 5, Buenos Aires, October 1988

60 Information supplied by the Instituto Nacional de Estadística, Geografía e Informática (INEGI), México, 1988

61 See C. Pereira Lucena, op.cit.

62 UNIDO, ID/WG. 478 (SPEC), op.cit., p.51

10. Human resources

No doubt, the development of human resources is one of the most critical components of any strategy for creating an industrial and technological basis in informatics and microelectronics. The lack of qualified personnel for research and development, design and engineering activities, management and teaching (especially at the university level) represent a significant bottleneck in most of the countries considered here. In the countries that have experienced a rapid development in those fields (such as the Republic of Korea and Singapore), the shortcomings as to available personnel emerge as an important limitation for future growth. In other cases, well illustrated by Argentina, the training of professionals and technicians in electronics has clearly exceeded the actual demand, due to the drastic reduction of production during the second part of last decade. The paradox now is that a large number of engineers and technicians are available, but their qualifications are to a great extent below those necessary for industry development.

The need to develop human resources in informatics and microelectronics has been felt in all countries considered here. Their responses, however, diverge considerably both in nature and in scope. In some cases moreover, efforts to improve graduate qualifications in overseas universities started in the 1960's and are already showing positive results. Massive overseas training was promoted in the Republic of Korea, as mentioned before, since 1965. Likewise, the extensive use of scholarships for the training abroad of scientists and engineers as promoted by the Mariscal Sucre Foundation in Venezuela, was significant in training the founders of many indigenous firms currently active in the professional electronics field. A considerable number of Indian nationals also received post-graduate education in engineering in the United States and other developed countries⁶³.

The opportunities for education in informatics and microelectronics technologies in the selected countries include in most cases several universities, specialized institutions and specific national programmes. In Argentina, eighty-eight university careers in informatics and in related disciplines are available. An explosive increase in educational demand on those areas took place during the last five years⁶⁴.

63 10.170 science and engineering doctorates were awarded to Indian citizens between 1960 and 1985 in the United States. See National Science Foundation, "Foreign citizens in U.S. Science and Engineering History, Status and Outlook", Washington, 1987.

64 In 1986, the number of informatics and related careers students reached 36000, equivalent to 5,6% of all university students. See Carlos M. Correa, op.cit.

Important shortcomings as to the number and qualifications of professors (only a minority have concluded post-graduate studies) is a major problem still to be solved. Equipment and software for teaching activities are also scarce. In order to substantially improve the level of university education in the field, the Argentine Government undertook various initiatives, among which two should be mentioned. On the one side, it set up a Latin American School of Informatics (ESLAI) with the aim of providing high-level training to a selected group of Argentine and other Latin American students. On the other, under the cooperation agreement entered into with Brazil in 1985, the government organised and financed annual Brazilian - Argentine Schools of Informatics (EBAI), where five hundred selected university students from both countries (and about fifty from other Latin American countries) receive courses from Argentine and Brazilian professors/.

In Mexico, there are seventy four university careers on informatics and twenty three post-graduate programmes. Until 1986, about 32,000 students had obtained degrees in that discipline. 35% of professors at universities have undertaken post-graduate studies and 9% have completed a doctorate.

Eighty seven institutions had high level courses and twenty five offered post-graduate titles in Brazil, in 1986. The government approved, in 1987, a programme for Master and Ph.D studies abroad, which will benefit 10,000 students by 1990.

The shortage of qualified personnel is strongly perceived in the Asian countries dealt with in this report. To reduce the gap, the role of universities in the training of scientists and engineers tends to be complemented by specific programmes. In India, for instance, "the gap between the availability and demand for skilled personnel to design, manufacture, apply, and maintain computers and develop software packages for using them, is estimated to rise to 80,000 by the end of Seventh Five Year Plan (1989-1990). As against the requirement, the proportion of professionals who have computer education/training from recognised institutions is estimated to have been about 5,000 in 1985-86 while the number of professionals required to implement even the existing computer activities optimally is 12,000"⁶⁵. Action to remedy this situation has included microprocessor training in the graduate and undergraduate curriculum; introduction of computer education (on a pilot basis) in secondary and higher secondary level schools; training of engineers from industries and other organizations in the field of microelectronics and its applications under the Appropriate Automation Promotion Programme (funded by the Indian Government and UNDP/UNIDO). The Department of Electronics supports training and continuing education programmes, while the state-owned Computer Maintenance Corporation has set up training centres in twenty for places.

65 EBAI professors are also requested to write a book on their respective subjects, which is later circulated in both countries.

66 Ashok Parthasarathi, op.cit, p.5

The Government of the Republic of Korea has set forth as a goal for the year 2000, to increase the number of scientists and engineers from 11 to 30 per 10,000 inhabitants (a level comparable to that of Japan). Likewise, it plans to bring back 2000 overseas trained scientists and engineers⁶⁷. Graduate and post-graduate training in the universities of the Republic of Korea has been reported as inadequate, except at a few institutions, but improving⁶⁸. The government set up the Korea Science and Engineering Foundation and the Korea Research Foundation in order to promote and finance research at the university laboratories.

67 Ministry of Science and Technology, op. cit.

68 See UNIDO IS/500, op.cit.

11. Summary and conclusions

Informatics and semiconductors constitute one of the most dramatic illustrations of the industrial and technological North-South asymmetry. Industrialized countries' firms -and particularly transnational corporations- dominate the innovative process, an overwhelming part of world production, distribution and commercialization channels. A few developing countries have made, particularly during this decade, considerable efforts to enter into those new fields on the basis of a nationally-led development. Others have achieved some significant participation in the international trade of products assembled locally by subsidiaries of foreign firms.

The countries selected for this study reflect a considerable diversity of situations in terms of market size, production capacities, industrial strategies followed, and other features.

Some countries have reached important levels of output in terms of world production, such as Singapore, the Republic of Korea and Malaysia in active components and -to a minor extent- Singapore and Brazil in informatics goods. In overall terms, Asian developing countries are ahead of Latin American countries in the dimension of their respective production in those fields.

Production in the areas and countries considered in this report is, for the most part, based on the assembly of imported parts and components. This is characteristic of countries like Malaysia, but it is also true of other countries that have significantly advanced in the development of an electronic industry, such as the Republic of Korea. With the launching of informatics policies in Argentina, Brazil and Mexico, attempts were made to attain a higher local content in national production, with very different results. In the Republic of Korea, important investments were made to introduce semiconductors manufacture from wafer fabrication.

Moreover, in Brazil and India the large potential of the domestic market and the perception of the strategic character of microelectronics and informatics technologies, among other factors, determined the adoption of strategies having technological self-reliance in the field as a long term goal. These models are based on the assumption that a "learning by doing" process will enable local producers to catch up technologically with industrialised firms and to assure the development of a domestic industry.

The industrial structure prevailing in the countries considered show the predominance of relatively large firms, and of a quite concentrated local supply. The Republic of Korea is the outstanding example, with a few conglomerates dominating the industry. In contrast, in some Latin American countries (Argentina, Mexico, Venezuela) small and medium enterprises seem to prevail.

One major difference in the strategies followed, relates to the approach towards foreign markets. Large continental economies (Brazil, India) and other countries with long import substitution tradition (Argentina), have focused on the production for the domestic market, while Asian countries dealt with (and Mexico) have clearly opted for an export-led model. The success reached by some of the latter countries (particularly Singapore and the Republic of Korea) is impressive as reflected in the exports to United States and other industrialised countries in recent years. A great part of such exports, however, is based on OEM arrangements, in which efficiency in production is combined with dependency on foreign firms' designs and, particularly, marketing networks. This weakness may become a dramatic shortcoming if protectionist trends in industrialised countries, particularly in the United States, are further strengthened.

It is interesting to note that, contrary to what is assumed, success in exports has not been necessarily associated with open competition in the domestic market. The Republic of Korea is a good example in that sense.

The role of the State in the development of the sectors studied has been relevant in most selected countries. In some of them, it also included direct participation in production, as illustrated by the case of India. Different types of public incentives are available in those countries, including for R&D activities, public procurement, etc.

On the other hand, foreign participation has also been important in general terms, but some countries have established significant limitations in order to enhance the role of nationally owned firms. Thus, while in Singapore and Malaysia foreign direct investments, and particularly transnational corporations, are the major industry's actors, in India and Brazil their role has been circumscribed in regard to the forms of ownership participation and to the type of products that they are allowed to produce. In the latter countries, as well as in the Republic of Korea, nationally-owned firms play an important role in the current development of the sectors considered.

Licensing of foreign technology has been an important tool to enter into the production of informatics goods and semiconductors in most countries. In some cases, those arrangements represented the first step in a process of technology absorption, that was later on complemented by an increased effort in R&D. Most of R&D in those fields in the countries reviewed has been financed or executed directly by public sector institutions. R&D within enterprises, however, has significantly expanded in some cases, such as in the Republic of Korea, Brazil and India. In overall terms, the R&D capabilities in the eight selected countries is limited and mostly concentrated on product development.

In the area of software production, despite the expectations of their potential for developing countries, so far, local industries in the countries considered are incipient, excessively fragmented and technologically weak. Local supply is mainly limited to application of custom-made software, though the development of some kind of basic software has been identified in Brazil, India and other countries.

Finally, notwithstanding the progress made in human resources development in the fields dealt with, all the countries reviewed face considerable problems, though of different nature. In some cases, the rapid expansion of informatics and microelectronics production and applications (e.g. South Korea, India, Singapore) has created a human resources demand very difficult to satisfy in the short term, particularly for highly qualified jobs. In other countries (e.g. Argentina) the increased interest for those disciplines cannot be adequately met by educational institutions, due, in particular, to an acute, lack of qualified teaching personnel.

In conclusion, the countries studied in this report present a wide range of achievements, development strategies, weaknesses and strengths that make it extremely difficult to attempt a comparative assessment. The elements derived from their experience, however, provide valuable information in order to understand the factors that may determine success or failure in high-technology fields. In particular, they may contribute to a more general -and much needed- discussion on the real opportunities that those fields offer for newly industrialising countries. Of course, the study made is neither exhaustive nor deep enough to derive definite conclusions. It shows, however, that the establishment of industrial, technological and marketing capabilities in those fields is a very complex matter and that they do not necessarily come together. It also indicates that some common assumptions -e.g. on the easy possibilities that software production and exports may open- are not more than misleading simplifications. In fact, the building up of those capabilities in informatics and microelectronics, will still require important efforts and, most probably, new strategies to survive in an extremely competitive and rapidly changing context.

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INTEGRATED CIRCUITS

Trends in Intellectual Property Protection*

Prepared by
Carlos M. Correa

* The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

CONTENTS

	<u>Page</u>
1. Introduction	1
2. National regulations	2
2.1 The U.S. Semiconductor Chip Protection Act	2
2.2 Impact of the SCPA	5
2.3 Legislation in other industrialized countries	8
3. The WIPO Treaty on Intellectual Property in respect of integrated circuits	12
3.1 The negotiations	12
3.2 Scope and content of the Treaty	15
4. Implications of the Treaty	30
References	32

1. Introduction

The issue of the legal protection of integrated circuits' lay-out designs has only emerged in the last ten years, during which time a hard-fought battle for the domination of an expanding world market has taken place. While that market represented, in 1987, around US\$ 30 billion (for semiconductors), what is really at stake in that battle transcends the sector's economic dimension. The industry of semiconductors is a leading sector because of its widespread economic impact on users and suppliers, and because of the broad research and development activities it involves in fields such as physics, chemistry and materials technology. Leaving aside national defense interests, it is strategic for competing in computers, telecommunications, consumer electronics and other segments of the growing market of semiconductor-based products which today is worth, roughly, US\$ 500 billion (Borrus, 1988, p. 37-39). For some analysts, moreover, "the chip war is ultimately a worldwide struggle for the dominance of an industry and technology that may well determine the geopolitical and economic leadership of the twenty-first century" (Warshofsky, 1989, p. 16).

The current efforts to establish an international system for the protection of the semiconductors' lay-out designs, mainly prompted by the initiative of the United States, reflects, on the one side, the present competitive struggle between the main actors in the field (basically large U.S. and Japanese firms) and, on the other, the profound world asymmetry as regards productive and technological capabilities for the manufacture of semiconductors. United States and Japan control around 90% of the world production. Other developed countries have entered the field, but, until now, with very limited results. A few developing countries -most notably the Republic of Korea- have also attempted to introduce themselves into the area.

This paper reviews the steps taken at the national and international level in order to strengthen the suitability of design-related innovations in the area of semiconductors. It briefly considers, in section two, U.S. legislation on the matter, which has helped to determine the speed and direction of the developments in this field. Section three contains a brief description of the negotiations undertaken in order to establish an international convention on intellectual property concerning integrated circuits, and examines the main provisions of the treaty adopted in May 1989. Section four contains some considerations on the likely impact of the said treaty and the main conclusions of the study.

2. National regulations

2.1. The U.S. Semiconductor Chip Protection Act

The majority of developed countries have already enacted specific legislation, or are in the process of doing so for the protection of lay-out designs of integrated circuits. The diffusion of such a legislation, on the basis of a sui generis approach, is a noticeable case of rapid internationalization of standards developed at the national level in order to satisfy the demands of a competitive domestic industry.

The United States was the first country to adopt, in November 1984, a special law for the protection of "mask works" (the "Semiconductor Chips Protection Act"-SCPA). The SCPA was the outcome of a five year - long debate prompted by the American semiconductor industry. A major concern of that industry, and one of the main objectives of the law, was to prevent a supposedly growing chip piracy, mainly originating in Japan, that could undermine the unquestionable supremacy -at that time- of U.S. firms in that field.

The debate of the draft law was a matter of substantial controversy between the Senate and the House of Representatives in establishing the form of protection to be granted. The Judiciary Committee of the U.S. Senate "favoured an amendment to the Copyright Act, on the basis that the Act was already used to cover a variety of highly functional items. The Senate also believed that the use of the copyright law would protect chips with certainty and stability. Any new statute has potential hazards as new concepts and terms often require judicial interpretation before they can be applied with certainty. In the opinion of the Senate committee, the Copyright Act could have been amended without any realistic threat to the integrity or efficacy of existing copyrights or future copyrights in the kinds of works for which copyright protection is already available. The Judiciary Committee of the House of Representatives took the opposite view. They believed that semiconductor chips are completely functional, having no copyrightable expression apart from their functional characteristics, and as such may present a different class of articles. The House committee noted that if the Copyright Act were to be amended it would give rise to a substantial inconsistency. Chips, which have no copyrightable expression and are completely functional, would be protected, while other articles which have both an expression and functional attributes, but in which the two cannot be separated, would not be protected" (Fitzsimons, 1987, p. 16).

Among the most conflicting issues, the debates highlighted the problem of applicability of the "fair use" doctrine and the compliance with national treatment obligations under the Universal Copyright Convention. Publishers were strongly opposed to any extension of the "fair use" concept to cover the practice of reverse engineering while, on its part, the U.S. semiconductor industry considered it unacceptable to confer protection in the United States to designs originating in countries where no substantial protection was granted (Fort, 1987, p.28).

The SCPA introduced a special title of legal protection for "mask works"¹ fixed in a semiconductor chip product. As shown below, the regulations adopted later on in other countries, as well as the WIPO Treaty, avoided the use of the "mask work" terminology, in view of the technological changes occurring in the fields of semiconductors' design and manufacture.

As under copyright, the SCPA made protection conditional upon the originality of the work. According to Section 902 (b) (2) of the U.S. Law, protection is not available for a "mask work" that is not original or consists of designs that are basic, commonplace, or familiar in the semiconductor industry, or has variations of such designs, combined in a way that, considered as a whole, is not original.

Under Section 904 (a) of the U.S. Law, protection of a mask work commences on the date of first commercial exploitation (unless it is preceded by registration under the US Law). In order to maintain protection, registration must be effected within two years from the first commercial exploitation (Section 908 (a)). Where first commercial exploitation precedes the registration, the protection ends, according to Section 904 (b) and (c), at the end of the tenth calendar year from the first commercial exploitation.

Section 901 (a) (5) of the referred Act defined "commercially exploitation" to mean the distribution to the public for commercial purposes of a semiconductor chip product embodying the mask work, with the proviso that such term includes an offer to sell or transfer a semiconductor chip product only when the offer is in writing and occurs after the mask work is fixed in the semiconductor chip product.

The SCPA also included specific rules on the registration of a mask work. According to Section 908 (a), its owner may apply to the Register of Copyrights for registration of a claim of protection. Such a registration is a prerequisite for maintaining the protection since Section 908 (a), second sentence, states that protection of a mask work terminates if application for registration is not made within two years after the date on which the mask work is first commercially exploited anywhere in the world.

Under U.S. law the certificate of registration constitutes prima facie evidence of the facts stated in the certificate (Section 908 (f)). "Thus, registration, in essence, amounts to a reversal of the burden of proof in an infringement action resulting in the defendant having to prove that the registered mask work does not deserve protection. Moreover, according to Section 910 (b), registration is required in order to institute a civil action for infringement" (WIPO f, 1988, Study 6, p. 12).

1 According to section 901 (a) "Mask work" is a series of related images, however, fixed or encoded:

- (A) having or representing the predetermined, three-dimensional pattern of metallic, insulating, or semiconductor material present or removed from the layers of a semiconductor chip product; and
- (B) in which series the relation of the images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product.

The Regulations issued by the Register of Copyrights in 1985 determined the information to be submitted in order to obtain registration. Among other relevant rules, it is interesting to note that they permitted the title-holder to retain trade-secrets. The treatment of the information for which a trade-secret is claimed depends, according to Section 211.5 (c) of said Regulations, upon whether or not the mask work has been commercially exploited prior to the time of the application to register the claim to the design².

An important provision of the law (section 906) refers to the exception of "reverse engineering". The law does not consider it an infringement for a person to reproduce the mask work solely for the purpose of teaching, analysing or evaluating the concepts or techniques embodied in it or the circuitry, logic flow or organization of components used in it, or to perform the analysis or evaluation mentioned above to incorporate the results in an original mask work which is made to be distributed. With this provision, "competitors may not only study protected mask works, but may use the results of that study to design, distribute and import semiconductor chip products embodying their own original mask works" (Greguras et al, 1985, p.61)³.

Another particularly relevant provision relates to the immunity for innocent purchasers of pirated chips. In accordance with section 907, an innocent purchaser of an infringing semiconductor chip product:

is not liable for merely using the chip product;

is not liable for the importation or distribution of the infringing product that occurs before the innocent purchaser has had notice of protection with respect to the mask work embodied in the product; and

is liable only for a reasonable royalty on each unit of the infringing semiconductor chip product purchased prior to notice and imported or distributed after having such notice. The amount of the royalty will be determined in a civil action for infringement unless the parties resolve the issue by voluntary negotiation, mediation or binding arbitration.

A provision which has been of particular importance for the rapid adoption of a sui generis regime for integrated circuits in developed countries, concerns the treatment of mask works belonging to foreigners. Section 914 established a well defined system of strict material reciprocity, i.e. protection in the United States was made conditional upon similar protection in the country of the foreign applicant.

2 For the detailed regulations on this issue see WIPO f, 1988, Study 6, p.13.

3 The House report stated that the intent of the reverse engineering exception was "to permit ... tge "unauthorized" creation of a second mask work whose layout, in substantial part, is similar to the layout of the protected mask work - if the second mask work was the product of substantial study and analysis, and not the mere result of plagiarism accomplished without such study and analysis" (quoted by Greguras el al, 1985, p.62).

Under the Act, the Secretary of Commerce may extend interim protection to nationals of foreign nations under certain conditions: (1) that the foreign nation in question is making progress (either by treaty negotiation or legislative enactment) towards a scheme of protection similar to that under the Act; (2) that its nationals and persons controlled by them are not engaged in misappropriation or the unauthorized distribution or commercial exploitation of mask works; and (3) that entry of the Secretary's order would promote the purpose of the Act and of achieving international comity toward mask work protection⁴. A system of presidential declaration was also made available under the SCPA⁵.

The SCPA, Finally, authorised the title-holder of a mask work to affix notice (either the word "mask work", the symbol *M* or the letter M in a circle) to masks and semiconductor chip products embodying the mask work, which has the consequence of a prima facie evidence of a "notice of protection".

2.2 Impact of the SCPA

While the congressional discussion was taking place, the superiority of U.S. firms in the semiconductors' world market was being seriously undermined. In 1975 the U.S share of that market was virtually 100 percent. In 1984, at the time when the SCPA was approved, that participation had fallen to about 60%. It was further reduced to 42% in 1988, when already six out of the ten major open-market producers of semiconductors were Japanese. "What is even more disturbing is that in the new generation of chips, the 1-megabit DRAMs, for example, the United States has only 5 percent of the market, a market that will grow significantly in the future as more and more systems are designed to take advantage of the greater memory capacity" (Warshofsky, 1989, p.12).

4 By the end of October 1985 the Patent and Trademark Office had received petitions from fourteen countries seeking protection of their semiconductor chip designs in the United States. Since the fourteen countries accounted for nearly all of the foreign semiconductor production, that Office did not expect any additional petition to take place (Carmichael, 1987, p.436).

5 According to section 902 (2) whenever the President finds that a foreign nation extends, to mask works of owners who are nationals or domiciliaries of the United States protection (A) on substantially the same basis as that on which the foreign nation extends protection to mask works of its own nationals and domiciliaries and mask works first commercially exploited in that nation, of (B) on substantially the same basis as provided by U.S. law, the President may by proclamation extend protection to mask works (i) of owners who are, on the date on which the mask works are registered or on the date on which the mask works are first commercially exploited anywhere in the world, whichever occurs first, nationals, domiciliaries, or sovereign authorities of that nation, or (ii) which are first commercially exploited in that nation. Until September 1988, no presidential proclamation had been issued (Laurie, 1988, p.17)

The decline of U.S. leadership in semiconductors cannot be attributed to the copying of American designs and technology. Japanese firms excel in the manufacturing of products at low cost with high quality. They beat U.S. firms mainly in manufacturing technologies, but also made important progress in product technology. From 1975 to 1982 the U.S. share of world patenting on integrated circuits fell from 43% to 27%, while that of Japan rose from 18% to 48%. Today, Japanese firms have a technological lead in most areas of semiconductors manufacture⁶ and, what is of crucial importance, they have also dramatically progressed in the field of production equipment: "Over the past decade, the Japanese equipment industry's world market share has more than doubled to over 30 percent, primarily at the expense of U.S. firms. Moreover, Japanese suppliers have reached parity or even superiority in major technologies, including packaging, automated assembly equipment, various ultrapure materials, some categories of fabrication equipment and specialized procedures such as mask making" (Ferguson, 1987)⁷.

Between 1985 and 1987 (September) the U.S. Copyright Office received 3.401 applications under the SCPA, and made 3.003 registrations. The majority of these correspond to U.S. firms (see table 1).

Table 1 Registration of lay-out designs of integrated circuits lay-out in United States*

	1985	1986	1987(*)	Total	
Total of applications	1.880	542	978	3.401	
Total of registrations	1.263	859	881	3.003	
Country of origin	United States	717	620	466	1.803
	Japan	481	179	380	1.040
	United Kingdom	39	20	30	89
	Netherlands	10	0	0	10
	Sweden	6	10	0	16
	Canada	5	18	1	24
	France	2	5	1	8
	F.R.G.	2	2	0	4
	Italy	1	0	2	3
	Ireland	0	4	0	4
	Australia	0	0	1	1
Finland	0	1	0	1	

Source: U.S. Copyright Office.

6 Significant Japanese advances have been recently reported in microprocessors, an area deemed to be the technological bastion of U.S. strength in computer components. See Chapman Wood, 1989, p.12.

7 Japan's makers of production equipment obtained solid market gains in 1988. Tokyo Electron leaped from the N° 6 slot in 1987 to N° 2 behind first-place Nikon Corp. and Canon Inc. moved N° 6 from N° 7. Just 10 years ago, the best that any Japanese company could manage was 15th. Business Week, 1989.

* Situation as of 30 September 1987.

The SCPA was one of the measures promoted by the U.S. industry to curb its gradual decline in world markets. As mentioned before, it was premised on the assumption of an important piracy activity, mainly by Japanese firms. However, as indicated by an American authority, "the perceived evil of chip piracy in the form of slavish copying, as portrayed during the legislative hearings, does not really exist. The pirate must copy exactly because, without an understanding of the circuitry, the smallest change in the topography could be fatal to the operability of the chip. The problem with this scenario is that, with a high level of integration (e.g. LSI or VLSI) in order to go from chip number 1 to photographs to magnetic tape to masks to chip number 2, the fabrication processes for chips 1 and 2 have to be virtually identical. Because such processes were highly proprietary to each chip developer, it was not likely that a pirate could duplicate them. Upon close examination, the few specific instances of chip piracy cited during the legislative hearings either involved relatively low density, highly repetitive designs such as 16K static RAM memory chips or were, in fact, examples of reverse engineering" (Laurie, 1988, p.35/37).

The litigation under the SCPA has been, in fact, almost nonexistent. The only case brought to the courts involved two American firms, Brooktree Corp. and Advanced Micro Devices Inc.. The plaintiff claimed that Advanced Micro Devices had copied two of the former's chips that represented 40% of its sales. The Court (Southern District of Carolina) found that the defendant presented evidence of a paper trail showing the various stages of the design process. It recalled that the SCPA does not prohibit independent development of a mask work, and that "an identical but original second mask work is not an infringement of the first". It also held, on the basis of section 906 of the law, "that the Mask Work Act was directed at minimal investment piracy rather than at the type of long-term research and reverse engineering it (the defendant) performed"⁸.

In view of the little judicial activity under the SCPA, Siegle and Laurie may be right in sustaining that the law still is "a solution in search of a problem" (Siegel and Laurie, 1989, p.14). Although continuing technical progress may eventually make copying easier in the future, undeniably the protective régime has not helped either to encourage innovation in U.S. industry or to prevent the rise of Japan as a strong competitor.

Certainly, the SCPA was not the only measure devised by the U.S. government for that purpose. In 1986 it concluded a "chip pact" with Japan trying, among other things, to monitor and maintain above certain levels chips' export prices. The Ministry of International Trade and Industry's (MITI) agreed to issue an administrative guidance to companies not to export semiconductors below cost; requiring semiconductor exporters to report export price data to the government; the systematic monitoring of export prices and production costs; and indirect quantitative production controls through supply-demand forecasts⁹.

⁸ The decision denied the plaintiff's motion for a preliminary injunction: (Civil No. 88-1750-E (CM), 13-12-88).

⁹ The Gatt Council found that guidance to be in violation of the GATT agreement (The Japan Economic Journal, 1988, p.22).

On the other hand, a joint industry-government-funded consortium (the Semiconductor Manufacturing Technology Institute-SEMATECH) was established in 1987 in order to develop a new generation of manufacturing technologies and, in particular, to improve the capabilities in the field of equipment for the production of semiconductors. SEMATECH received contributions from IBM, ATT and other large firms, including in terms of designs, masks and test data bases of advanced chips (such as the 4-megabit DRAM of IBM) (Warshofsky, 1989, p. 367..The Defence Department decided to contribute as much as US\$ 600 million over six years to support SEMATECH activities.

Finally, the 1938 amendment to the Trade Bill included the setting up of a National Advisory Committee on Semiconductors, with the main function of recommending the allocation of R&D funds and preventing duplication of effort in federal laboratories and academic institutions.

2.3. Legislation in other industrialised countries

Notwithstanding the feeble impact of the SCPA on the overall performance of the United States in the semiconductors field, the Act had a considerable influence on other developed countries' legislation. Certainly, the stringent reciprocity clause of the SCPA constitutes a major factor explaining the rapid adoption of the new sui generis approach by many countries. The special chips legislation had no precedent in those countries. In some of them -such as in United Kingdom, Holland, Canada¹⁰, Australia¹¹ - lay-out designs were deemed to be protectable under copyright¹². In other countries, unfair competition was considered applicable¹³.

The first country to react to the U.S. law was, not surprisingly, Japan. In May 1985, "the Act concerning the circuit lay-out of a semiconductor integrated circuit" (law No 43) was promulgated. The Japanese law is modelled on the SCPA. A number of differences can, however, be identified.

10 The Government of Canada announced in February 1986 that mask works fixed in semiconductor chips would be protected by the Copyright Act but that such works would be distinguished from traditional works (WIPOb, 1986, para. 39).

11 In Australia chips lay-out designs were considered artistic works. See Fitzsimons, 1987, p. 18.

12 After the enactment of the SCPA copyright may also be applied in the United States to lay-out designs which have not been fixed or which have not complied with some conditions for protection. See Laurie, 1988.

13 Article 5 of the Swiss revised law on Protection Against Unfair Competition (1986), entitled "Exploitation of the Achievement of Somebody Else", provides in Section (c) an act of unfair competition is committed by a person who, by means of technical processes of reproduction and without corresponding sacrifices, takes over the results of the work of somebody else which are ready to be put on the market and exploits them as such.

First, the Japanese law defined the "circuit layout" of a semiconductor integrated circuit, and not the "mask work" as the subject matter of protection. It thus avoided a reference to a concept linked to a technology prevailing at the time the SCPA was drafted, but focussed on the process of being substituted by other methods (use of an electron beam under the control of a computer) that do not require the use of a mask. Second, the conditions for protection of a lay-out (originality, non-commonplace, etc) are not spelled out. There must be just a "creation". Third, law 43 did not establish reciprocity requirements based on the nationality or domicile of the applicant. Fourth, the Japanese law made protection conditional upon the registration of the lay-out, which should be effected within two years of its first commercial exploitation. Fifth, according to one interpretation, the "reverse engineering" exception would be more restrictive than under U.S. law, for it would not permit copying from a first chip into a second reverse engineered chip (Kitagawa, 1986). Finally, under Japanese law infringement may result in criminal punishment.

A significant number of applications under the Japanese law were effected immediately after its enactment. In November 1987, 1353 lay-outs had been registered (see table 2). While in the case of the registration in the United States, Japanese firms held, 31% of total applications (see table 1), U.S. firms only accounted for 12% of applications made in Japan. The majority of registrations made in Japan corresponded, on the other hand, to bipolar (47%) and MOS (48%) integrated circuits (see table 3).

Table 2 Registration of lay-out design of integrated circuits in Japan*

	1986	1987*	Total
Total of applications	840	513	1.353
Total of registrations	838	510	1.348
Country of origin			
Japan	748	416	1.164
United States	78	87	165
Netherlands	10	0	10
United Kingdom	3	6	9
F.R.G.	0	4	4
France	1	0	1

Source: Industrial property Cooperation Center

(*) Situation as of 30 November 1987.

Table 3 Applications by type of lay-out designs of integrated circuits in Japan (1986)

Bipolar	391	47%
MOS	406	48%
Bi-MOS	27	3%
Other	16	2%
Total	840	100%

Source: Industrial Property Cooperation Center.

In December 1986, Sweden approved a law on lay-out designs of integrated circuits (N° 1425). Unlike the U.S. and Japanese precedents, no registration system was established. Protection is granted from the creation stage (no fixation is required), but it lasts for ten years after the first commercial exploitation of the lay-out design. Almost simultaneously, the Council of the European Communities approved a Directive "on the legal protection of topographies of semiconductor products" (87/54/EEC).

One important innovative feature of the EEC Directive was the adoption of a new terminology ("topography") to define the subject matter of protection¹⁴, that has been subsequently applied in the relevant European laws. The Directive required the existence of "an intellectual effort" (and not "originality") for protection. It authorised Member States to establish registration as a condition for protection and to require the presentation of material identifying or exemplifying the topography (which should not be made available to the public, however, where it is a "trade secret"). The provision on "reverse engineering" presented some differences in relation to the U.S. model and to the Japanese law (Hart, 1987, p. 5). Further, the EEC Directive included a provision on non-voluntary licenses, which states the cases in which the Member States cannot grant them, i. e. "for the sole reason that a certain period of time has elapsed, automatically, and by operation of law" (art. 6). This broad provision has permitted a Member State -Spain- to establish in its national law the possibility to grant non-voluntary licenses for reasons of "public-interest" (article 6, law of May 1988).

14 According to article 1 of the Directive, the "topography" of a semiconductor product shall mean a series of related images, however fixed or encoded.

(i) representing the three-dimensional pattern of the layers of which a semiconductor product is composed; and
(ii) in which series, each image has the pattern or part of the pattern of a surface of the semiconductor product at any stage of its manufacture.

A number of other countries adopted thereafter sui generis laws to protect semiconductor lay-out designs. These included United Kingdom, Federal Republic of Germany, France, Netherlands, Denmark, Spain, Austria, Australia and Italy¹⁵. Notwithstanding some differences, they all followed the approach inaugurated by the SCPA and conferred a ten-year term protection under comparable conditions. To a great extent, hence, the United States had succeeded in translating its national law into an international standard, at least in most developed countries.

The integrated circuits protection, as suggested before, is a remarkable example in the development of international economic law. It shows how technological and political power may determine the shape and extent of regulations in a given area, for a very specific issue and on the basis of almost completely new standards. As warned by the delegation of the Federal Republic of Germany at one of the sessions of the Committee of Experts convened by WIPO, there is a risk "of creating separate systems of sui generis protection for all new technologies"¹⁶. A matter of concern, also, is the "regression to the old reciprocity principle which historically had already been abandoned and replaced by the national treatment regime of the world-wide intellectual property treaties (Cohen Jehoram, 1987), as a means to shape international norms of protection."

As indicated in the next section, the process of internationalization of the sui generis regime for semiconductors further manifested itself in the work expeditiously undertaken by WIPO in order to establish an international treaty on the matter. While that work was progressing, United States and Japan submitted proposals for discussing the same matter in the framework of GATT negotiations on intellectual property rights (Correa, 1989).

15 Draft laws have also been reported in Switzerland and Norway.

16 The German expert also "questioned whether it would not be advisable to create a system of protection on a wider level, similar to the protection against unfair competition, prohibiting the unlawful appropriation of the works of others" (WIPOa, 1985).

3. The WIPO Treaty on intellectual property in respect of integrated circuits

3.1 The Negotiations

Soon after the adoption of the SCPA, the Secretariat of WIPO established the grounds for the discussion of an eventual international convention on the matter, based on the concept of a sui generis protection. In 1985, a first draft treaty was prepared and circulated, and a Committee of Experts on the matter was held in November of that year. At the outset, developing countries were reluctant to discuss the establishment of a new treaty on the matter. The main questions raised dealt with the economic and legal justification for such a convention, as well as the form that the protection should adopt. Developed countries, on their part, welcomed the WIPO initiative. In particular, the delegation of the United States called attention "to the need for integrated circuit protection so as not to hinder progress in integrated circuit technology, and was of the view that there should be an international commitment to recognize and respect the property rights in original layouts or designs of integrated circuits under appropriate conditions" (WIPO a, 1985).

Four meetings of Experts were held between 1985 and 1998 in order to consider the draft treaty. In addition, WIPO convened two consultative meetings of experts of developing countries¹⁷ and prepared a set of studies "dealing with legal matters" concerning intellectual property in respect of integrated circuits¹⁸.

The criticism of developing countries¹⁹ mainly concerned the lack of justification for the establishment of an international treaty on the basis of a special protection for lay-out design of integrated circuits, as well as on specific aspects of the draft proposed by WIPO Secretariat. The absence of sufficient and convincing reasons for developing countries to legislate on the matter was emphasised by many developing countries (WIPO c, 1988, p.3). India indicated, in particular, that the draft treaty did not provide a well-balanced solution, since it did not adequately address and protect the interests of all parties concerned, especially the interests of the developing countries (WIPO, 1988c, p.2). The Mexican delegation, on its part, argued that it was not clear that the introduction of a sui generis treaty was the best option, and that rather than affording protection, it should promote technology transfer.

17 Experts from seven developing countries - Argentina, Brazil, China, Egypt, Ghana, India and Indonesia-participated in such consultations.

18 Developing countries requested at the Third Session of the Group of Experts studies on a number of issues, including economics of production of integrated circuits, technological aspects, transfer of technology, rationale for protection and specific legal problems. See WIPOc, 1987.

19 The analysis that follows is partially based on the author's paper "Intellectual property in the field of integrated circuits. Implications for developing countries". prepared for the Development Center (OECD), May 1989

"At present", the expert said, "the semiconductor industry was concentrated almost entirely in developed countries, and the protection of its creations benefited them exclusively. The budding electronics industry of developing countries was mainly engaged in the assembly of equipment and systems, and was still heavily dependent on components such as circuits that were designed and manufactured by a few transnational corporations. Against this background it was not easy to accept that there should be a desire to strengthen still more the position of the manufacturers of integrated circuits by means of a treaty that covered not only the copying of the designs but also the marketing of the circuits and articles that contained copied designs" (WIPO c, 1988, p. 8-9).

The type of protection to be granted has also been the subject matter of considerable discussion. Argentina held that unfair competition would be the most appropriate way to cover the issue, under the terms of article 10 bis of the Paris Convention. Brazil and South Korea suggested that utility models or industrial designs legislation could be appropriate. For India, integrated circuit lay-outs are a copyrightable matter and that country formally submitted a draft codicil to the Berne Convention.

Several developing countries pointed out imbalances of the proposed international treaty. Argentina stressed "the serious imbalance existing between the type of protection that was being proposed and the low standards that had to be met for the design of an integrated circuit to be eligible for protection" (WIPO c, 1988, p.4). The expert from the Republic of Korea stated that the sui generis approach favoured the interest of proprietors, and was less favourable for the general public: "since the proprietors of rights in respect of layout-designs would mainly be large companies in industrialized countries, laws for the protection of layout-designs must also guarantee the interests of the general public against abuse of rights. Thus, the possibility of compulsory licenses must be introduced into a sui generis law for the protection of layout-designs. In addition, he emphasised the difficulty of reverse engineering for enterprises in developing countries, owing to inadequate equipment and technology, so that the protection granted to a proprietor must be balanced by a requirement of clear disclosure to the general public of the subject matter and the scope of protection" (WIPO c, 1988, p.15).

While contesting the rationale of the protection and the approach adopted, developing countries participating in WIPO negotiations also questioned specific aspects of the proposed treaty, which closely follows United States and other industrialized countries' legislation. Among other points of concern, several countries stressed the need to provide for non-voluntary licenses. According to an expert from India "the possibility of reverse engineering under the draft treaty was not a sufficient reason to deny non-voluntary licensing because, reverse engineering was only possible by large companies and needed large investments and adequate infrastructure, which would put such efforts in the developing country environment at a disadvantage" (WIPO a, 1988, p.2/3). A system of non-voluntary licenses may be particularly important to satisfy public interests (e.g. in the area of safety, defence or health) and to avoid abuses by the title-holder in cases where there are no capabilities in the country to undertake an independent development or to reverse engineer a protected lay-out design.

One of the most criticised points related to the extension of the protection to chips incorporated in industrial articles. Given the pervasiveness of microelectronics, it becomes in effect extremely difficult, particularly for developing countries, to investigate and determine whether the chips incorporated in various types of products are original or not. While some developing countries denied the existence of a right of the design owner in such a situation, others argued that though the protection does not terminate with the incorporation of a chip into a broader product, a different (more restricted) legal action on the commercialization of the latter should be granted.

Provisions on innocent infringement were also highly controversial, particularly as they could relate to the products that incorporate chips. According to an expert from Mexico, innocent third parties "should be indemnified by the persons who copied the designs, rather than being obliged to pay compensation as was being provided in the draft Treaty. The expert considered that third parties should be exempted from liability under the Treaty, and not only those who purchased the actual integrated circuits. The user should not be affected; the seller, not the purchaser, should be penalized" (WIPO c, 1988, p.22). In addition, it was argued, a letter by the design title-holder notifying an infraction could "block a whole series of commercial acts that third parties might be engaging in. On the other hand, the same letter could rely on exclusive entitlement to an integrated circuit that had been granted pursuant to the provision on confidentiality. The result would be that the supposed infringer would not be able to find out anything about the protected subject matter, even by approaching the industrial property offices that had granted the title of protection" (WIPO c, 1988, p.23).

The limitations on disclosure and the eventual creation by the WIPO draft treaty of a multilateral system of trade secrets protection, were consistently opposed by several developing countries. The expert from the Republic of Korea, for instance, proposed that the contents of the layout-design should be disclosed to the general public in a gazette "particularly, a short description of the lay-out design and claims should be contained in the application and be filed with the registration office" (WIPO c, 1988, p.15). The lack of full disclosure was also criticised by Brazil, as constituting one of the far-reaching conceptual changes in intellectual property title and one of the factors determining the lack of balance between the rights and obligations emerging from the proposed system (WIPO c, 1988, p.8).

Finally, a maximum of 5-7 years duration for a title on chips' design was sustained by most developing countries. In accordance with the expert from China "the duration of protection for layout-designs of integrated circuits, should be less than the life-time of the technology, since the owner of the right in the technology should be entitled to profit from his investment during the early part of the life of the technology, while society as a whole should profit from the technology during the latter stage of the technology's life" (WIPO c, 1988, p.12).

In sum, at the time the Diplomatic Conference for establishing a treaty on the matter was convened, considerable doubts and hesitation prevailed among developing countries. None of these countries had legislated on the matter and have not yet done so. For most of them, moreover, the issue of integrated circuits protection was not only new but was not among the areas of immediate concern in the field of industrial development or trade policies.

On the other hand, after the preparatory work was carried out under WIPO auspices, the views of developed countries on the content of a future treaty seemed to be considerably harmonised. In fact, no substantial differences were perceived during discussions of the Committee of Experts' discussions, except for a few matters in which final common positions were not reached. Clearly, those countries unanimously favoured the adoption of an international convention on the matter.

3.2. Scope and content of the Treaty²⁰.

The Diplomatic Conference convened in Washington from May 8 to 26, 1989, and approved with 49 votes the text of an international convention, based on the draft prepared by the WIPO Secretariat (WIPO d, 1989). Developing countries and the majority of developed countries, in particular the EEC, found a common ground to establish acceptable international standards on the issue. Japan and the United States voted against the text finally approved²¹. As discussed below, the issue of non-voluntary licenses and the treatment of industrial articles that contain infringing chips were the main points of disagreement for the two countries that, paradoxically, control around 90% of world production and trade of semiconductors.

Notwithstanding the relatively well-defined scope of the discussions, many delegations strongly felt that the decisions taken at the Conference would transcend the field of integrated circuits. For instance, it was believed that the treatment afforded to the issue of the non-voluntary licenses could affect the negotiations on the revision of the Paris Convention and other discussions within GATT²². Likewise, the provisions on disclosure and settlement of disputes could be relevant for other areas. Moreover, the Treaty was an important test for the ability of WIPO to manage international negotiations vis-a-vis GATT.

20 Hereinafter referred to as "the Treaty". The text of the Treaty is included in the Annex.

21 Five countries (Sweden, Canada, New Zealand, Vatican and Lichtenstein) abstained.

22 According to some observers, the eventual impact of the wording of article 6.3 on other sectors, and particularly on pharmaceuticals, affected the final position of the U.S. delegation on the Treaty.

The following paragraphs contain a brief analysis of the discussion and of the approved text of the main provisions of the Treaty.

a) Definitions.

The discussions on definitions concentrated on two substantial issues (the concept of "integrated circuit" and of "lay-out design/topography"), and on the question of defining an "International Organization" with the effect of becoming a Contracting Party to the Treaty.

Unlike the WIPO Secretariat's draft, the Conference opted for defining "integrated circuit" instead of "microchip". The definition makes it clear that it covers "a product in its final form or an intermediate form", a clarification deemed essential by the United States²³ and other Group B delegations. The basic point behind this amendment to the draft relates to the protection of "gate arrays" and other integrated circuits (e.g. Programmable Logic Devices-PLDs) which cannot be considered "finished" products. The replacement of the phrase "capable of performing a function" by "intended to perform..." addressed also the problem of such intermediate products.

Another important discussion took place in connection with the applicability of the Treaty to integrated circuits containing only one active element. While some proposals made could have been interpreted as allowing the protection of "discreet" components -which was unacceptable for developing countries-, the compromise solution clearly indicates that such components are not covered by the Treaty.

As regards the definition of "lay-out design (topography)" ²⁴, the approved text avoids implication regarding the requirement of fixation as a condition for protection. Moreover, it is clear that the three-dimensional disposition of the elements may be in any form ("however expressed"). U.S. and Japanese law include the actual fixation of the lay-out into a microchip among the conditions to be met to obtain protection. Some developing countries at the Conference held the view that it was convenient to retain such a requirement in the text, in order to avoid protection to merely theoretical designs. Developed countries -particularly Australia, Norway, the EEC- and a number of developing countries argued, in contrast, that the protection of unincorporated designs would be of benefit to countries that may have design capabilities but not those necessary to manufacture the chips. The solution adopted followed this second approach though, as far as developing countries are concerned, the practical validity of the argument is doubtful. Till now, in effect, those countries have produced

23 The issue of protection of intermediate forms is still unclear in the United States. Though the Semiconductor Industry Association, for instance, maintains the protectability of "cell libraries" and "standard cells" they are not deemed eligible by the Copyright Office (Laurie, 1988, p. 25)

24 The use of this combined expression, agreed upon during the preparatory work for the Conference, avoided complex discussions on the most appropriate terminology to be applied in this field.

very few integrated circuits designs which have become internationally traded, and there is no reason to expect the development of a special comparative advantage in that field in the near future. Almost all the discussion of the draft treaty was based on the problems of the semiconductor industry. Those concerning independent "design houses" only emerged explicitly at the Conference itself. The role of such houses and the extent to which the protection devised may be necessary for their activities, would require further investigation.

The issue of the "Intergovernmental Organization" was brought up by the EEC desire to become a party to the Treaty independently from its member States. Having approved common rules on the matter (EEC Directive of December 1986), the member States have transferred to the Community the competence to be, as such, a party to an international convention on the matter (WIPO e, 1989). The approved text admitted that possibility.

b) Subject matter

The Treaty provision on the subject matter of protection does not differ substantially from the one discussed during the preparatory work. It spells out in para 3.1.a the basic obligation under the Treaty i.e., to secure intellectual protection in respect of lay-out designs, but leaves to each country the freedom to choose the measures to ensure the prevention of the acts considered illegal under article 6.

Para 3.2.a determines the requirements for protection of a lay-out design by combining the concept of "originality" and that of "intellectual effort" (employed in the U.S. and in the EEC regulations, respectively). It also adds as a qualification the condition -expressly provided for in the U.S and in the U.K legislation- that the lay-out should not be "commonplace among creators of lay-out designs (topographies) and manufacturers of integrated circuits at the time of their creation"²⁵.

Article 6.2.b of the Treaty (approved by the Conference upon a proposal, of the Soviet Union, later on modified) clarifies the extent of the title-holder rights in respect of another lay-out design which is identical. It makes it clear that those rights cannot be exercised against a third party if such a design has been independently created. A fortiori, the same rule would apply if the result is not an identical but a similar or substantially similar design independently developed.

The provision contained in 6.2.b. -though technically superfluous- is a strong indication of the radical difference existing between the rights conferred under the Treaty and the protection granted under patent law and other titles of industrial property. Those rights do not confer exclusivity neither on the functionalities of the design nor on a specific expression thereof. They only protect, in essence, against copying; more precisely, the protection is only against slavish copying and not against that based on an own "intellectual effort" (see point e below).

25 Article 3.2.b of the Treaty specifies, however, that "a layout-design (topography) that consists of a combination of elements and interconnections that are commonplace shall be protected only if the combination, taken as a whole, fulfils the conditions referred to in subparagraph (a)"

Article 3 contains two paragraphs which did not appear in the draft text. On the one hand, it states that "the right of the holder of the right in respect of an integrated circuit applies whether or not the integrated circuit is incorporated in an article". This insertion -proposed by the Group of 77 during the final negotiations- was a compromise offered in order to avoid an explicit reference in article 6 to industrial articles that incorporate infringing microchips²⁶. Many developing countries, as mentioned before, considered it unreasonable to treat on the same footing the cases of sale, importation and other forms of distribution of pirated chips and those where the latter are incorporated in industrial articles. While accepting the principle that the right of the title-holder does not terminate with the incorporation of a chip in an article, those countries did not want to accept that the title-holder would have exactly the same legal actions in those two different situations. In effect, it may be extremely difficult to determine whether chips imported or incorporated in imported products are infringing or not, especially if -as discussed in the framework of GATT negotiations- custom authorities are obliged to adopt measures at the border. If the title holder of the rights relating to a chip is, for instance, authorised to stop the importation of industrial articles because they may include an infringing chip (independently of its relevance both in terms of cost and function in the product)²⁷ trade flows could be significantly distorted.

On the other hand, article 3 incorporated a paragraph allowing any country to limit protection to semiconductor integrated circuits. The Treaty definitions do not specify the type of material in which the lay-out may be incorporated. Most laws in force (in U.S., Japan, EEC countries, Denmark, etc.)²⁸, however, specifically refer to "semiconductor products", a limitation that many countries would like to be free to apply.

c) The legal form of protection

Article 4 was adopted without significant discussion. It was introduced in the draft text at the request of developing countries during the preparations for the Conference, in order to allow different countries to apply existing intellectual property laws for chips protection. While exercising this freedom, however, the Contracting Parties are bound to comply with the obligations under the Treaty.

26 Such a reference was eliminated from articles 6.1. and 6.4., as drafted by WIPO Secretariat. Article 6.5 of the draft ("articles temporarily or accidentally entering the territory of a Contracting Party"), which could also have implications on this problem, was also deleted.

27 In some cases (e.g. computers) chips may be an essential part of the product. In others, however, they may be incidental both functionally and as a proportion of total cost (e.g. a digital clock in a car)

28 One exception is the recently enacted Australian law on the matter which applies in general to "circuit layouts" without specifying any material.

Article 12, however, provides that the Treaty "shall not affect the obligations that any Contracting Party may have under the Paris Convention for the Protection of Industrial Property or the Berne Convention for the Protection of Literary and Artistic Works". According to the interpretation of the Director General of WIPO, the effect of that article is that "if a Contracting Party chose to implement its obligations under the Treaty through a law made, totally or partly, on the basis that layout-designs are works under the copyright law or are a subject matter of industrial property law, and that Contracting Party is a party not only to the proposed Treaty but also to the Berne Convention or the Paris Convention, the said law must be compatible not only with the proposed Treaty but also with that or those Conventions. For example, if a Contracting Party considered layout-designs to be works under its copyright law and was a party to both the proposed Treaty and the Berne Convention, layout-designs would have to be protected without formalities (even though the proposed Treaty admits formalities) and for 50 years after the death of the author (even though the proposed Treaty admits a shorter period of protection). Or, if the Contracting Party is party to both the proposed Treaty and the Paris Convention and protects layout-designs by patents for inventions or utility models, layout-designs would require the grant of a patent or other official certificate (even though the proposed Treaty admits protection without any procedure before a government authority)" (WIPO d, 1989, p. 66).

If the interpretation quoted in the precedent paragraph is correct, there will not be much advantage for a country which adheres to the Treaty to apply copyright law in this field. An almost natural option will be to establish a special regime for the protection of layout-designs, in order to reasonably limit the term and other rights of the "creator". If a title of industrial property were to be applied, the trade-offs of the different possible solutions should be carefully weighed. Clearly, patents confer a much stronger right than the sui-generis régime. Unfair competition might be the sole institution under which some room for manoeuvre may be found. However, to the extent that any Contracting Party is obliged to comply with the Treaty's minimum standards, the final result may not be too different from the application of a sui generis approach.

In other words, the flexibility apparently created by article 4 is de facto limited by the need to comply with the Treaty's compulsory standards and by its article 12. In a final analysis, the best that a country adhering to the Treaty could probably do is to establish a law that deals with the specificities of integrated circuits protection.

d) National Treatment

As mentioned before, the SCPA contained a strict material reciprocity clause. It "often has been regarded as the most blatant and severe stroke ever led against the principle of international treatment by a developed nation" (Dreier, 1988, p. 9). In fact, most regulations enacted in order to respond to the U.S. law -including the EEC Directive- also incorporated that condition, with the noticeable exception of the Japanese law. As stated by Dreier in respect of the SCPA, "this had exactly been its purpose: to incite foreign nations to explicitly grant protection for semiconductor chips - and this irrespectively of the question, whether traditional laws were in fact inappropriate or not. In this respect, the legislative history contains sufficient material to believe that mere affirmative statements that protection would already be provided for by existing copyright laws would have just as few chances to be accepted as references made to unfair competition law. Consequently, in order not to have the products of their own nationals unprotected within the US and not to lose the US market, other chip-producing industrialized nations didn't have much choice but to comply with the SCPA's legal mechanism" (Dreier, 1988, p. 7).

Given the results of the reciprocity clause of the SCPA and the de facto considerable harmonisation of the legislation of developed countries on the matter²⁹, it was a logic step to expect a movement towards the establishment of an international treaty that set down the minimum standards of protection including a restoration of the national treatment principle. Article 5 of the Treaty precisely states that principle, the application of which is in any case subject to the compliance of the obligations under the Treaty. The approved text introduces some amendments to the draft treaty, which was based on the Paris Convention wording. It refers specifically to a real and effective establishment for the "creation" of lay-out designs or for the "production" of integrated circuits. This text implicitly reflects the exclusion of the "fixation" criterion as well as of a mere "commercial" establishment as a basis to benefit from national treatment.

e) Scope of protection

1) Acts requiring the authorization of the title-holder

Article 6 may be regarded as the core of the Treaty, for it establishes the content and limitations of the title-holder rights and, therefore, the extent of the minimum standards of protection to be respected by the Contracting Parties.

Article 6.1 enumerates -in a non-taxative way- the acts that require the title-holder authorization. On the one side, since non-fixed lay-out designs are eligible for protection, the reproduction "by incorporation in an integrated circuit or otherwise" will be unlawful if made without authorization (except for non-original parts of the design). This provision, as drafted, comprises the total or partial reproduction of the lay-out design on a mask, on a computer tape, on paper, or by any other means including the manufacture of a microchip (WIPO d, 1989, p. 30).

29 Such an harmonisation has been, however, partial in many respects. The EEC Directive, for instance, gave the member States the option to choose between copyright or a specific protection, or a cumulation of both (see Cohen Jehoram, 1987, p.38)

On the other, the Treaty specifies the unlawfulness of the acts of "importing, selling or otherwise distributing for commercial purposes a protected layout-design (topography) or an integrated circuit in which a protected layout-design (topography) is incorporated" if made without authorization. All references to the unlawfulness of the same acts when performed in respect of industrial articles that contain infringing integrated circuits were omitted. As indicated above (see point b of this section), such an omission was a critical part of a broader negotiating compromise. In fact, as noted by some delegates of developing countries, the majority of regulations on the matter (with the clear exception of those of United States and Japan) do not explicitly mention industrial articles. Many delegates of developing countries thought that the solution adopted in the Treaty will leave national legislative and judicial authorities more flexibility to determine the concrete measures applicable in each case.

ii) Reverse engineering

Although no explicit mention is made in the Treaty, it clearly contains the exception of reverse engineering, which has been common practice in the semiconductors industry. It is also formally recognised -although with some differences- by national laws enacted until now on the matter. The pertinent provision -article 6.2.a- is, like the totality of article 6, self-executing, i.e. no special provision at the national level would be required in order to give it full effect. Said provision, on the other hand, not only authorizes reverse engineering, which has an industrial aim, but other acts made for "private purposes" or for the "sole" purpose of research or teaching. This means that the reproduction of a lay-out design, for instance, at a university laboratory for purposes of training, is to be deemed legal.

Provision 6.2.b. clarifies the extent of the reverse engineering exception. It states that as long as there is an intellectual effort involved (which is necessary to comply with the originality requirement) the rights of the title- holder of the reverse engineered design cannot be used against the creator of the second design.

The Treaty should be interpreted in the sense that it permits the copying of original parts of a first lay-out design into a second one, as long as the latter is also original. As mentioned before (see point b above), only "slavish" copying is illegal, but not that based on an intellectual effort.

iii) Non-voluntary licenses

Determinant in the refusal by United States and Japan of the final text of the Treaty, and considered critical by developing countries, the provision on non-voluntary licenses was one of the most difficult issues dealt with by the Conference. The approved text was the result of intense negotiations around the basic draft prepared by WIPO Secretariat

prepared by the WIPO Secretariat and new proposals submitted by the EEC and the United States³⁰.

The adopted provision constitutes an important departure from the original position of the Group of 77. However, its basic concept -the possibility of granting a non-voluntary license "to safeguard a national purpose deemed to be vital" by the national authority -satisfied to a considerable extent the Group's expectations. On the other hand, the text reflects a number of conditions derived from various proposals of developed countries, which set out the framework in which such licenses can be granted. Those conditions are a) the "non-ordinary" character of the circumstances to be taken into account; and b) the existence of previous "unsuccessful efforts" made "in line with normal commercial practices"³¹.

30 The Group of 77 unanimously supported, during the negotiations, alternative A of the WIPO Secretariat's draft on article 6.3.a.1 with a clear and unqualified reference to "public interest" as a premises to grant such licenses. The United States proposal based on the text submitted by that country in GATT for standards on patents, limited the applicability of compulsory licenses "to address, only during its existence, a declared national health or public safety emergency, or to remedy an adjudicated violation of antitrust or other law designed to secure fair competition and to prevent abuses of dominant market position, or to allow use exclusively for governmental purposes". The EEC proposal read as follows: "(a) Notwithstanding paragraph (1), any Contracting Party may, in its legislation, provide for the possibility of its executive or judicial authority granting a non-exclusive license for the performance of any of the acts referred to in paragraph (1) by a third party without the authorization of the holder of the right after serious and unsuccessful efforts to obtain such authorization ("non-voluntary license") where the granting of non-voluntary license is found, by the granting authority, to be necessary for the safeguard of a vital public interest, i.e. defense or public health; the non-voluntary license shall be subject to the payment of an equitable remuneration by the third party to the holder of the right, which remuneration shall, in the absence of agreement between the third party and the holder of the right, be fixed by the granting authority. (b) The granting authority of any non-voluntary license, and fixing of equitable remuneration, referred to in subparagraph (a) shall be subject to judicial review. Any such license shall be revoked when the facts that justify it cease to exist. (c) A non-voluntary license granted under this paragraph shall not be assignable. (2) Further declaratory note on Article 6 (3): For the purposes of the application of Article 6 (6)," a non-voluntary license cannot be regarded as replacing the consent of the holder of the right". The text added that the following declaratory note should be inserted in the records of the Conference as note to para. (a): "The provisions of this Treaty are without prejudice to any measures taken under the legislation of the Contracting Parties intended to secure free competition".

31 The reference to "normal commercial practices" was negotiated against the deletion - sought by developing countries - of a criterion according to which the remuneration for the license should be commensurate with the "market value" of the license.

Further, article 6.3 determines the terms whereunder a non-voluntary license can be granted. It must be a) non-exclusive; b) available only for the domestic market³²; c) subject to the payment of "an equitable remuneration"; d) subject to judicial review; and e) revokable when the conditions that justified its granting have ceased to exist. These terms are considerably more restrictive than those authorized by the Paris Convention, and in particular than those proposed for its revision by developing countries. Under such Convention, in particular, there is no restriction relating the market and the license may last for the lifetime of the title. In exchange, the Paris Convention does not refer to the broad concept of "national purpose".

In addition, article 6.3.b. recognises the right of any country " to apply measures, including the granting, after a formal proceeding by its executive or judicial authority, of a non-voluntary license, in application of its laws in order to secure free competition and to prevent abuses by the holder of the right"³³. The drafting of this provision may allow two ways of interpretation. It may be construed, on the one hand, as permitting the control of abuses only to avoid distortions to "free competition". A second valid interpretation is that the regulations for the control of abuses need not be necessarily aimed at dealing with competition problems. In fact, many abuses may stem from situations where competition is not affected³⁴.

It is doubtful to what extent the provision on non-voluntary licenses of the Treaty may affect future negotiations on other areas of intellectual property. The Group of 77 may claim a relative success, due to the recognition of the notion of "national purpose" and the possibility to act against "abuses". Group B, on its part, obtained the insertion of a number of limitations that innovate in the field of compulsory licenses. Of course the nature of the right ensured under the Treaty substantially differs from those granted under industrial property rights and, in particular, in the patents field, where a stronger monopoly is conferred. A likely conclusion for many developing countries is that the type of provision reached in the Treaty -for a title which does not prevent more than copying- should a fortiori apply to stronger titles. Of course, if the text of article 6.3 is taken into account, a substantial trade-off will exist with regard to the conditions to be met for granting a license.

32 With this restriction developed countries wanted to exclude the use of the license to make exports, particularly to countries where the lay-out designs are not protected. The possibility of making such a use, in the field of patents, is recognised by some legislations, e.g. in Mexico.

33 The adopted text avoided the implication contained in the Group B proposal in the sense that the license could only be granted on the basis of existing antitrust legislations. The Group of 77 argued that such a legislation does not exist in many countries, and that other measures to avoid abuses should be equally applicable.

34 A still unresolved debate on the tests to judge abuses in business practices took place during the negotiations of an international Code of Conduct on Transfer of Technology. The Group of 77 upheld the applicability of a "development test" significantly broader than the test based on competition rules. See Correa, 1988, p. 10.

iv) Innocent infringement

Another important issue of discussion at the Conference concerned the content of the provision on "innocent infringement". The controversial point was the inclusion or not of a reference to the payment that the innocent infringer should make after knowing that he was dealing with unlawfully copied microchips³⁵. The adopted text limits itself to establishing -as a mandatory provision for all Contracting States- the exception in favour of such an infringer. Developing countries' main concerns related to the implications of the payment provision for the acquirer of articles incorporating infringing microchips (finally eliminated from article 6, as mentioned before) and to the treatment of the products held in stock by the innocent acquirer.

Being silent on the payment issue, article 6.4 wisely leaves the question of the consequences of the infringement to national laws.

v) Exhaustion of rights

Article 6.5 introduces the well-known exception of "exhaustion of rights", as a facultative provision for Contracting States. Its main aim is to ensure that after the first sale of a microchip is made, by the title-holder or with his consent, he can not prevent "parallel imports" of the products already put in the market. As explained in the notes to the draft treaty, "it follows from the drafting of the provision in paragraph (6) that Contracting Parties would be free to provide for national exhaustion (where rights are exhausted only when the first authorized sale occurs on the territory of the Contracting Party), regional exhaustion (where rights are exhausted when the first authorized sale occurs on the territory of a region to which the Contracting Party belongs), or international exhaustion (where rights are exhausted following a sale anywhere in the world)" (WIPO d, 1989, p. 6).

35 The draft text proposed a clause supported originally by the Group B according to which the innocent infringer "shall be obliged to pay the holder of the right an equitable remuneration in respect of each microchip imported, sold or otherwise distributed, as part of some other article or separately, for commercial purposes, after actual notice has been given to the said person by the holder of the right that the reproducing or incorporation had been done without his authorization, the amount of such remuneration to be fixed, failing agreement between the parties, by a court or an other impartial authority designated by legislation" (WIPO d, 1989)

Further, article 6.3 determines the terms whereunder a non-voluntary license can be granted. It must be a) non-exclusive; b) available only for the domestic market³²; c) subject to the payment of "an equitable remuneration"; d) subject to judicial review; and e) revokable when the conditions that justified its granting have ceased to exist. These terms are considerably more restrictive than those authorized by the Paris Convention, and in particular than those proposed for its revision by developing countries. Under such Convention, in particular, there is no restriction relating the market and the license may last for the lifetime of the title. In exchange, the Paris Convention does not refer to the broad concept of "national purpose".

In addition, article 6.3.b. recognises the right of any country " to apply measures, including the granting, after a formal proceeding by its executive or judicial authority, of a non-voluntary license, in application of its laws in order to secure free competition and to prevent abuses by the holder of the right"³³. The drafting of this provision may allow two ways of interpretation. It may be construed, on the one hand, as permitting the control of abuses only to avoid distortions to "free competition". A second valid interpretation is that the regulations for the control of abuses need not be necessarily aimed at dealing with competition problems. In fact, many abuses may stem from situations where competition is not affected³⁴.

It is doubtful to what extent the provision on non-voluntary licenses of the Treaty may affect future negotiations on other areas of intellectual property. The Group of 77 may claim a relative success, due to the recognition of the notion of "national purpose" and the possibility to act against "abuses". Group B, on its part, obtained the insertion of a number of limitations that innovate in the field of compulsory licenses. Of course the nature of the right ensured under the Treaty substantially differs from those granted under industrial property rights and, in particular, in the patents field, where a stronger monopoly is conferred. A likely conclusion for many developing countries is that the type of provision reached in the Treaty -for a title which does not prevent more than copying- should a fortiori apply to stronger titles. Of course, if the text of article 6.3 is taken into account, a substantial trade-off will exist with regard to the conditions to be met for granting a license.

32 With this restriction developed countries wanted to exclude the use of the license to make exports, particularly to countries where the lay-out designs are not protected. The possibility of making such a use, in the field of patents, is recognised by some legislations, e.g. in Mexico.

33 The adopted text avoided the implication contained in the Group B proposal in the sense that the license could only be granted on the basis of existing antitrust legislations. The Group of 77 argued that such a legislation does not exist in many countries, and that other measures to avoid abuses should be equally applicable.

34 A still unresolved debate on the tests to judge abuses in business practices took place during the negotiations of an international Code of Conduct on Transfer of Technology. The Group of 77 upheld the applicability of a "development test" significantly broader than the test based on competition rules. See Correa, 1988, p. 10.

iv) Innocent infringement

Another important issue of discussion at the Conference concerned the content of the provision on "innocent infringement". The controversial point was the inclusion or not of a reference to the payment that the innocent infringer should make after knowing that he was dealing with unlawfully copied microchips³⁵. The adopted text limits itself to establishing -as a mandatory provision for all Contracting States- the exception in favour of such an infringer. Developing countries' main concerns related to the implications of the payment provision for the acquirer of articles incorporating infringing microchips (finally eliminated from article 6, as mentioned before) and to the treatment of the products held in stock by the innocent acquirer.

Being silent on the payment issue, article 6.4 wisely leaves the question of the consequences of the infringement to national laws.

v) Exhaustion of rights

Article 6.5 introduces the well-known exception of "exhaustion of rights", as a facultative provision for Contracting States. Its main aim is to ensure that after the first sale of a microchip is made, by the title-holder or with his consent, he can not prevent "parallel imports" of the products already put in the market. As explained in the notes to the draft treaty, "it follows from the drafting of the provision in paragraph (6) that Contracting Parties would be free to provide for national exhaustion (where rights are exhausted only when the first authorized sale occurs on the territory of the Contracting Party), regional exhaustion (where rights are exhausted when the first authorized sale occurs on the territory of a region to which the Contracting Party belongs), or international exhaustion (where rights are exhausted following a sale anywhere in the world)" (WIPO d, 1989, p. 6).

35 The draft text proposed a clause supported originally by the Group B according to which the innocent infringer "shall be obliged to pay the holder of the right an equitable remuneration in respect of each microchip imported, sold or otherwise distributed, as part of some other article or separately, for commercial purposes, after actual notice has been given to the said person by the holder of the right that the reproducing or incorporation had been done without his authorization, the amount of such remuneration to be fixed, failing agreement between the parties, by a court or an other impartial authority designated by legislation" (WIPO d, 1989)

g) Exploitation, registration and disclosure

Like most national laws on the matter, the Treaty spells out in article 7.1 some conditions on which protection may be made conditional. Since the protection of unfixed lay-out designs prevailed at the Conference, that provision gives the freedom to grant protection from the time of the creation of the design (as under the United Kingdom regulations), to subject it to "commercial exploitation" (like most laws in force do) or even to registration (like in the United States to institute civil actions, in Japan and other countries). This article may, thus, allow different existing laws to maintain their present solutions and new regulations to adopt any of the referred bases for protection. They could even opt, for instance, to require commercialization plus registration within a certain period of the latter, as in United States and Japan, in order to confer or to maintain protection.

Article 7.1 refers to "ordinarily" commercially exploited lay-out designs. Such a qualification emerged as a compromise vis-a-vis the proposal of developing countries to refer to "public" exploitation. That proposal was intended to exclude situations in which a lay-out design may be commercialized under confidential terms, without being apparent to the consumer public and to competitors. In fact, that concern has been addressed by many regulations and, in particular, by the EEC Directive and West European laws on the matter³⁶.

A point of particular importance for many delegations related to the extent of disclosure to be required under the Treaty, on the understanding that its provision on the matter will be the maximum a national law could demand. For developing countries, the discussion on this issue was viewed as transcending the integrated circuits field, to the extent that it could create a precedent for other areas. In particular, it was feared that through the Treaty a multilateral system for trade-secrets protection could be established.

36 According to the EEC Directive, for instance, "commercial exploitation shall not include exploitation under conditions of confidentiality to the extent that no further distribution to third parties occurs, except where exploitation takes place under conditions of confidentiality required by a measure taken in conformity with Article 223 (1) (b) of the Treaty". The UK regulation of 1987 provides, along these same lines, that "no account shall be taken of any commercial exploitation which is subject to an obligation of confidence in respect of information about the topography exploited unless either-

- (a) the topography has been commercially exploited on a previous occasion (whether or not subject to an obligation of confidence), or
- (b) the obligation is imposed at the behest of the Crown, or of the government of any country outside the United Kingdom, for the protection of security in connection with the production of arms, munitions or war material".

Between the desire of some developing countries to include a reference to the "electrical schematic diagrams" of the chips, and that of developed countries of being able to exempt the title-holder from presentation of any confidential material, the adopted solution represents a fair compromise. On the one hand, the applicant may be required (though not necessarily, given the non-mandatory nature of this provision) to describe the "electronic function that the integrated circuit is intended to perform". On the other, he is not obliged to submit information relating to the "manner of manufacture" of the integrated circuit, provided that the information supplied is sufficient for the identification of the lay-out design.

At the moment, there does not seem to exist great harmonisation on this matter among developed countries (in some of them, such as Sweden and the United Kingdom, moreover, no registration is required). The Treaty will not certainly contribute very much to that harmonisation, given the range of options at hand for national authorities to deal with registration procedures.

Article 7.2.b contains a limitation for those countries that at the same time require commercial exploitation and registration to grant protection. The latter cannot be imposed before two years from the date of first commercialization anywhere in the world. This minimum period was necessary, according to some developed countries' delegations, for the title-holder to prepare the information to be supplied or to present the samples of the microchips. That term may be, however, significantly longer than really needed for that purpose in view, in particular, of the speed with which developments take place in the semiconductors field (a few months may be crucial for success or failure in that market). In any case, to the extent that the duration of protection could be counted from the creation of a lay-out design (see following point) or from the date of first commercial exploitation, the implications of the said rule on the term of protection can be reduced.

h) Duration of the protection

The Conference overcame complex discussions on the term of protection, by virtue of a finally accepted, informal proposal of the WIPO Director General, which very simply states that "protection shall last at least eight years". While many countries held that five years were sufficient, others wanted longer terms. In practice, ten years was the standard set out by the SCPA for the regulations adopted in other developed countries. The Treaty, on the one hand, allows for a lower minimum. On the other hand, it is silent about the date from which the term is to be counted. This again leaves freedom to apply different solutions, such as from first commercial exploitation, application for registration or registration. One open question is whether a country could decide to count that term since the creation of the lay-out design, however determined. Nothing in the Treaty seems to exclude such possibility. In fact, some laws recognise protection from the creation date³⁷.

37 See, for example, art. 5.b of UK regulations of 1987.

1) Settlement of disputes

Article 14 of the Treaty introduces an important innovation in the area of international conventions on intellectual property. Notwithstanding a general initial reluctance of the Group of 77, the Conference was able to get an agreement on the basis of a revised version of the proposal contained in the draft text (which was based on a draft submitted by the United States at the fourth session of the Committee of Experts). Unlike the Paris and Berne Conventions, which only provide for the right to resort to the International Court of Justice in order to solve interpretation or enforcement disputes, the Treaty sets out procedures for consultations, failing which a panel may be constituted in order to analyse the facts and make recommendations. On that basis, the Assembly created by the Treaty (which shall meet in ordinary session once every two years) shall, "by consensus, make recommendations to the parties to the dispute, based upon its interpretation of this Treaty and the report of the panel" (article 14.4).

The texts considered by the Conference resembled, with differences, the proposal for settlement of disputes adopted at the GATT Mid-Term Review Meeting of Montreal, in December 1988. They were certainly inspired by the GATT procedures. It was strongly felt by most delegations that notwithstanding the specific field under discussion, the text to be approved would have implications in other discussions of intellectual property within WIPO and elsewhere.

As compared to the draft proposal (which was only incorporated by WIPO as an "alternative"), the adopted text contains a number of improvements. First, it includes a new paragraph on "other means of settlement" such as good offices, conciliation, mediation and arbitration to which the parties may agree to resort. Second, the conditions for the setting up and functioning of the panel have been specified with more detail, including, in particular, the possibility for the parties to the dispute to agree on the terms of reference for the Panel's work. Third, the panel is to be convened by the Assembly (and not by the Director General of WIPO). Fourth, the Treaty requires the Assembly to adopt rules on the selection of panel members and for the panel proceedings. Fifth, article 14.3.c determines the procedures to be followed by the panel and the participation the parties to the dispute may have. Sixth, and most important, the outcome of the process does not include the possibility for the Assembly to authorize or apply sanctions to the Contracting Party deemed to have violated the Treaty, or to its nationals. Such a possibility was deemed unacceptable by many delegations, particularly from developing countries.

4. Implications of the Treaty

The adoption of the Treaty constitutes, no doubt, an important step in the process of internationalization of the sui generis approach first established by the United States. Paradoxically, for this country, the Conference is far from representing a success, as evidenced by its negative vote. In fact, the outcome of the negotiations contradicted most expectations. Developing countries expected a considerably unified Group B and, basically, a North-South confrontation on the main issues. Their ability to influence what seemed a relatively easy agreement among developed countries was deemed low. On the other hand, many delegations in Group B expected the Group of 77 either to block the negotiations or to maintain a purely defensive strategy. Both sides were wrong. Important differences emerged within the Group B, while the Group of 77 was active in looking for compromises that leave some freedom for national legislation and that soften the minimum standards to be applied.

If the actual productive and innovative capabilities are taken into account, one possible interpretation of the Conference results is that the countries that are mainly users, and not producers, of semiconductor chips were able to reach an agreement on terms unsuitable, however, for the major producers. The interest of the EEC to conclude the negotiations certainly cannot be explained by its desire to be accepted, as such, as a Contracting Party (in fact, the Community already is party to a number of conventions). Its endorsement of the adopted text, jointly with developing countries, seem to indicate, in reality, that major powers may face some obstacles at the time of promoting international standards for intellectual property.

An important question is what the attitude of the United States and Japan will be as regards the Treaty. If they do not accede to it, there will be a convention that leaves aside, as mentioned, nearly 90% of world production of chips. Given that -according to article 11.2.c- no proposal for the amendment of the Treaty can be made before the expiration of five years from the date of entry into force, an early revision of the Treaty cannot be expected. In addition, though the matter of integrated circuits was submitted by the United States and Japan for consideration in the Uruguay Round, there is no room at all for those countries to reopen the discussions on the issue within GATT.

Another important question is what the strategy of the United States vis-à-vis WIPO and GATT will be in the field of intellectual property. Certainly, any claim of failure of WIPO in its role of strengthening international protection of intellectual property would be unjustified. The organization has proved its ability to conciliate very different interests and, in particular, to involve a large number of developing countries in the design and establishment of international norms. Despite the fact that very few among such countries could have an actual interest in the area of semiconductors, a significant number of them have supported the text of the Treaty. Moreover, the "New Industrializing Countries" (NICs) have been among the most active during the whole process of negotiations.

From the perspective of developing countries, the Treaty represents a compromise (with certain flexibility in key provisions such as non-voluntary licenses), conditions for protection (including disclosure requirements) and legal consequences of the importation of articles incorporating infringing chips, with fairly balanced provisions on duration and settlement of disputes. For many of them, the adherence to the Treaty may be desirable not because of its eventual impact on local design activities, but in order to avoid unilateral actions by developed countries, such as those that could be implemented under section 301 of the U.S. Trade Act.

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